Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

NOV 24 1952

cluding the

JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 1579)

d the

JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 1593)

this issue . . .

- Flow Sheets and Control Diagrams
- Lube-oil Instrumentation
- Blast-furnace Inwall Temperature
- Instrument Electronics
- Tractor Design Measurements
- Research vs. Industrial Instrumentation
- Bellows-type Flowmeters
- 116 New Instruments
- 135 New Bulletins

A test bench of Streeter-Amet Co., Chicago, uses an oscillograph and electronic switch by DuMont, a VTVM and power supply by Hewlett-Packard, a multi-turn "Helipot," and a Veeder-Root counter to test servomechanisms in an "Ametron" instrument. *(Story on page 1486.)*

. 25 No. 11
VEMBER • 1952

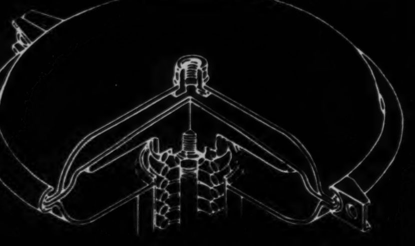
Missile with a "one track mind"

... Bomber Defense

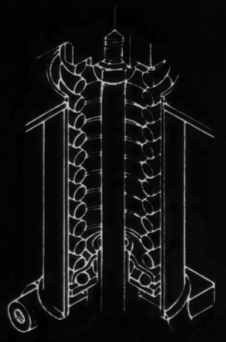
Defensive guided missiles launched from supersonic aircraft will depend upon electronic marvels that come as close to simulating human intelligence as any mechanism ever devised. Important functions of these "weapons of the future" are typical of those entrusted to systems made by Arma Corporation.

Complex electronic and electro-mechanical controls from Arma are an integral part of many of America's most advanced weapons. In basic research, design, development and manufacture, Arma Corporation has worked in close cooperation with the Armed Forces since 1918—and more recently, the Atomic Energy Commission. *Arma Corporation, Brooklyn, N. Y.; Mineola, N. Y. Subsidiary of American Bosch Corporation.*

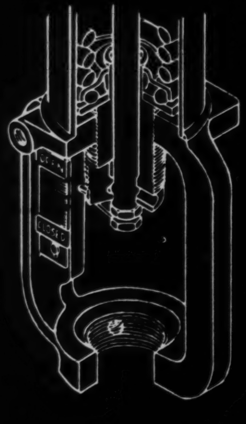
ARMA ADVANCED ELECTRONICS FOR CONTROL



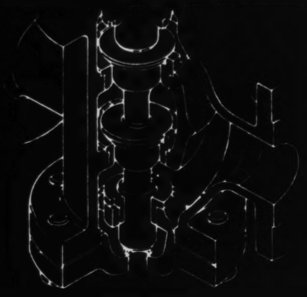
The K & M molded diaphragm has an exceptionally large effective area and it maintains full contact with the diaphragm button throughout the full valve stroke.



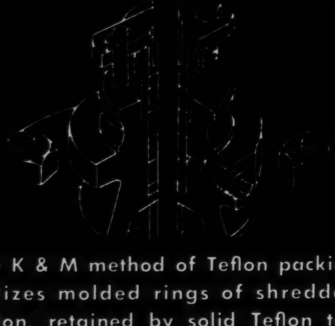
The heavy, long-travel K & M valve spring is calibrated for precise deflection rate. It combines with the large diaphragm to provide an exceptionally high power-factor. Inner valve positioning is extremely precise.



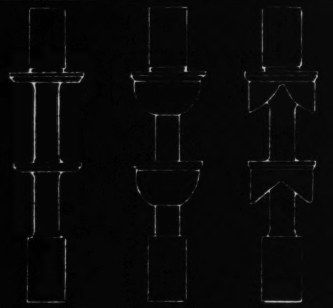
Steel spring barrel and steel yoke provide the strength required for long, hard, shock-resistant service.



Body flow passages are a minimum of 140% of comparable pipe size area—smooth, turbulent-free, high capacity flow is assured. Inner valve open areas average 80% of comparable pipe area—pressure drop takes place principally through the inner valve where it is fully controllable.



The K & M method of Teflon packing utilizes molded rings of shredded Teflon, retained by solid Teflon top and bottom rings. The need for compression members is eliminated, and with it the danger of corrosion or contamination of packing box parts.

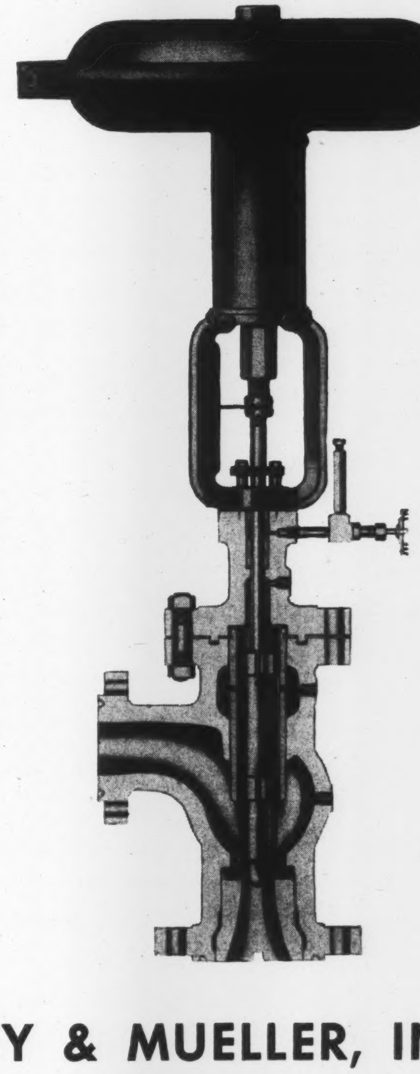


K & M inner valves are available in wide variety to provide desired flow characteristics for all process applications.

K&M CONTROL VALVE

No other control valve has the features of a K & M valve. No other control valve is designed so explicitly to meet the requirements of modern instrumentation.

No other control valve is backed by an organization so wholeheartedly interested in helping instrument engineers to solve exacting application problems.



NEWEST K&M CONTROL VALVE

The K & M Type 1460 is a new angle valve especially developed to handle high pressure drops and fluids containing slurry, sludge, coking and similar contaminations. It is particularly adapted for applications in modern refineries and petro-chemical plants. Available in sizes to handle pressures up to 1,500 pounds, and can be furnished in various metals and alloys for highly corrosive and high temperature service.

K&M

KIELEY & MUELLER, INC.

Valve Makers Since 1879

2021-43rd STREET **NORTH BERGEN, NEW JERSEY**

Quality is assured with
FALSTROM

INSTRUMENT PANELS and CONTROL BOARDS

Benchboard Console
Five Section Cubicle Control Board and Lighting Canopy
Corner Cubicle Section
Refinery Cubicle with Mimic Flow Diagram in Color

Superior Engineering MAKES FALSTROM YOUR LOGICAL CHOICE!

Experienced designing and quality fabrication assure the efficiency of any indicating, recording, or control installation. Whether you are planning new construction, modernizing existing installations or adding to present equipment, FALSTROM offers long years of experience and the most modern facilities for fabricating to your specifications or recommending standard designs. In any case, by specifying FALSTROM you specify the highest possible quality metal working techniques known to the industry. Estimates on your needs will be supplied promptly—call or write FALSTROM to arrange a consultation.

WRITE FOR BULLETIN #125

Visit us at the 20th Natl. Power Show
Dec. 1st to 6th, Booths 543 and 544
Grand Central Palace, New York City

SINCE 1870 FALSTROM COMPANY
92 Falstrom Court, Passaic, New Jersey
DESIGNERS, ENGINEERS AND BUILDERS OF CUSTOM METAL PRODUCTS FOR INDUSTRY

Instruments
THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Vol. 25 NOVEMBER, 1952 No. 11

FEATURE ARTICLES

Process Flow Sheets and Instrument Control Diagrams 1566
By W. L. Willoughby

Lube-oil Processing and Instrumentation 1568
By E. W. Midlam and J. D. Dorsey

Blast-furnace Inwall Temperature 1571
By Samuel J. Paisley

SERIAL

Instrument Electronics 1572
By Milton Aronson

THE MONTH'S NEW INSTRUMENTS...... 1526

INSTRUMENTS ON THE MARCH

ITV in Railroading 1614

Card Catalog of Infrared Spectra 1614

New Extensometer 1614

Ultra-high Vacuum Demonstrator 1614

MANUFACTURERS' NEW LITERATURE...... 1616

OTHER REGULAR FEATURES

Editorial Comment 1525

Calendar of Important Instrumentation Events 1576

Advertisers' Index 1628

JOURNAL of the INSTRUMENT SOCIETY OF AMERICA 1579

Measurements in Tractor Design and Development 1582
By R. P. Wehrle

Research vs. Industrial Instrumentation 1586
By Delmas C. Little

JOURNAL of the SOUTHERN CALIFORNIA METER ASSOCIATION

Rupture-Proof Bellows-Type Orifice Meters 1593
By A. I. Thompson

Copyright 1952 by The Instruments Publishing Company, Inc. Office of publication, 1600 North Main Street, Pontiac, Illinois. Executive and Editorial Office, 921 Ridge Avenue, Pittsburgh 12, Pennsylvania.

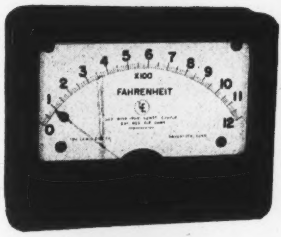
Entered as second class matter, October 14, 1949, at the post office at Pontiac, Illinois, under the act of March 3, 1879.

LEWIS

AUTOMOTIVE AND INDUSTRIAL TEMPERATURE MEASURING EQUIPMENT

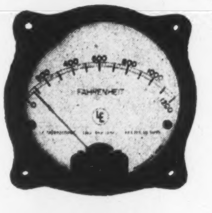
Sturdy Dependable Indicators —Suitable For Use In Moving Vehicles or For Permanent Installation

This instrument has been used extensively by the leading motor-car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in a rectangular bakelite case, this reliable, fully compensated pyrometer is furnished with 6 in. hand drawn scales for greater accuracy. The Model 58PY is available for use with all standard thermocouple materials, in many ranges to suit the most exacting application.



MODEL 58PY

Manufactured with the same type of movement as our aircraft pyrometers, the Model 23B pyrometer is well suited for use in moving vehicles and has been successfully used in many marine diesel installations for measuring exhaust temperatures. It is housed in a 4 in. round bakelite case that is flanged for panel mounting, and is available in several ranges for use with various thermocouple materials.



MODEL 23B

The Model 20B series of indicators are patterned after our standard aircraft instruments and are supplied with 3" round steel cases suitable for panel installation. These compact, sturdy indicators have 2⅛ in. scales, are fully cold-end compensated and are available in many ranges for use with various thermocouple materials.

FAHRENHEIT
0 1 2 3 4 5 6
X100

MODEL 20B

The Model 62RT4F resistance thermometer is a sturdy easy-to-read instrument with a 6 in. hand drawn scale. It is suitable for use in moving vehicles and is excellent for flight-test work. It is operated by an ordinary dry cell and is calibrated to standard "AN" bulb curves for various ranges in fahrenheit or centigrade.

MODEL 62RT4

THERMOCOUPLES for use with the above indicators are available in many styles for special applications. We have developed a complete line of aircraft, industrial and automotive thermocouples and would be pleased to offer our recommendation for your application.

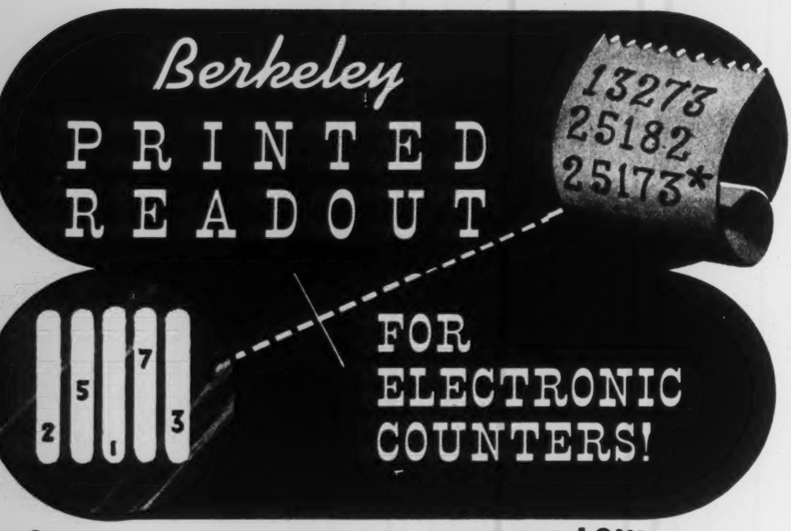
THERMOCOUPLE LEAD WIRE for connecting thermocouples to the indicators is manufactured in iron-constantan, copper-constantan or chromel-alumel material with standard and special insulation. Use Lewis lead-wire with Lewis instruments and thermocouples for best results.

RESISTANCE BULBS for use as sensing elements for the 62RT4 thermometers are available in several types for various applications, for measuring free air or liquid temperatures. We invite inquiries on your application.

THE LEWIS ENGINEERING CO.

Specialists in Electrical Temperature Measurements

NAUGATUCK, CONNECTICUT



• DIRECT READING • RAPID CYCLING • LOW COST

PRINTED READOUT for high speed electronic counters is now available at low cost as a standard BERKELEY product! This Digital Recorder provides a direct means of permanently recording sequential count information in arabic numeral form on a standard adding machine tape. It is designed to operate from electronic counters, Time Interval Meters, Events-per-Unit-Time Meters, nuclear scalers, and other electronic totalizing devices. Most standard BERKELEY instruments now in use can be readily adapted for operation with the BERKELEY Series 1550 Digital Recorder, thus eliminating the need for purchase of new counting equipment.

DIGITAL RECORDER . . . Series 1550 is composed of a Readout unit and a Printing Recorder. The first unit consists of a bank of readout decimal counting units essentially paralleling the totalizing function of the basic counting instrument from which they operate, and a selecting relay matrix to channel information from the counting circuit to the Printing Recorder. This second unit presents a sequence of total counts in direct reading digital form on a standard adding machine tape.

A COMPLETE SYSTEM . . . of Electronic Counter and Digital Recorder then consists of three elements: a suitable electronic counting device, Readout unit, and Printing Recorder. The latter two elements comprise the complete Digital Recorder. Under certain conditions a special modification of the system will permit original count information to be channeled directly into the Readout unit, thus eliminating the need for a separate electronic counter.

SPECIFICATIONS . . . Minimum counting period determined by the characteristics of the basic counting instrument. Maximum cycling rate: 1 printout every ¾ second. Indicating capacities 3, 4, 5 or 6 columns. Readout Unit—20¾" x 10½" x 15" cabinet, wt. 60 lbs., standard 19" relay rack panel. Printing Recorder—7½" x 8¼" x 14½" cabinet, wt. 20 lbs. Price, Digital Recorder, Model 1553 (3-column), $1050; Model 1554 (4-column), $1125; Model 1555 (5-column), $1200; Model 1556 (6-column), $1275, f.o.b. factory.

M-2

Please request Bulletin 6011

Berkeley Scientific
division of BECKMAN INSTRUMENTS INC.
2200 WRIGHT AVENUE • RICHMOND, CALIFORNIA

"DIRECT READING DIGITAL PRESENTATION OF INFORMATION"

Instruments
THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Published by
The Instruments Publishing Company
921 Ridge Avenue
Pittsburgh 12, Penna.

Richard Rimbach, *Publisher*
M. F. Behar, *Editor*
Milton H. Aronson, *Technical Editor*
James F. Emge, *Assistant Editor*

DISTRICT OFFICES AND MANAGERS

***Altadena, Calif.*, M. D. Pugh, 2721 N Marengo Ave., Telephone Sycamore 7-2894**

***Boston* 14, James Condon, 133 Marlborough St., Telephone Commonwealth 6-5961**

***Chicago* 1, Harold W. Haskett, Room 615, 360 N. Michigan Ave., Telephone Andover 3-4299**

***Cincinnati* 5, Harold W. Haskett, 742 Elberon Ave., Telephone Grandview 4323**

***St. Louis* 1, *Mo.*, James R. Wright (Missouri, Southern Illinois, Southern Indiana), Stephen E. Wright (Iowa, Nebraska, Kansas), 411 N. 10th St., Telephone Chesnut 1965.**

***New York* 17, Richard Rimbach, Jr., Room 349, 551 Fifth Ave., Telephone Murray Hill 2-0821**

***Philadelphia* 40, William J. Gallagher, Room 1102, Beury Bldg., 3701 N. Broad St., Telephone Baldwin 9-9940**

***Pittsburgh* 12, C. Goldcamp, 921 Ridge Ave., Telephone Fairfax 1-0161**

***Dallas, Texas*, Edward F. Wright, Oklahoma-Texas-Louisiana, 505 N. Ervay, Rm. 310.**

***London*, W.C. 2, England. John C. N. Hughes, Crown House, 143-147 Regent St., London W. 1, England**

COVER STORY

A typical test set up at Streeter-Amet Co., Chicago, shows an Ametron Electronic Recorder assembly having servo circuit checked-out. The instrument has an automatic zero-balance control, and is designed to perform a hopper cut-off operation in a huge food-batching machine for the processing industry. Other phases of test operation, arranged to simulate actual operating conditions, are utilized throughout the research, development, and production of this electromechanical equipment.

MEMBER
ABC
Audit Bureau of Circulation

SUBSCRIPTION RATES
For One and Two Years.

United States, U. S. Possessions, and Canada $4.00, $7.00.

Latin America and Australia $5.00, $8.00.

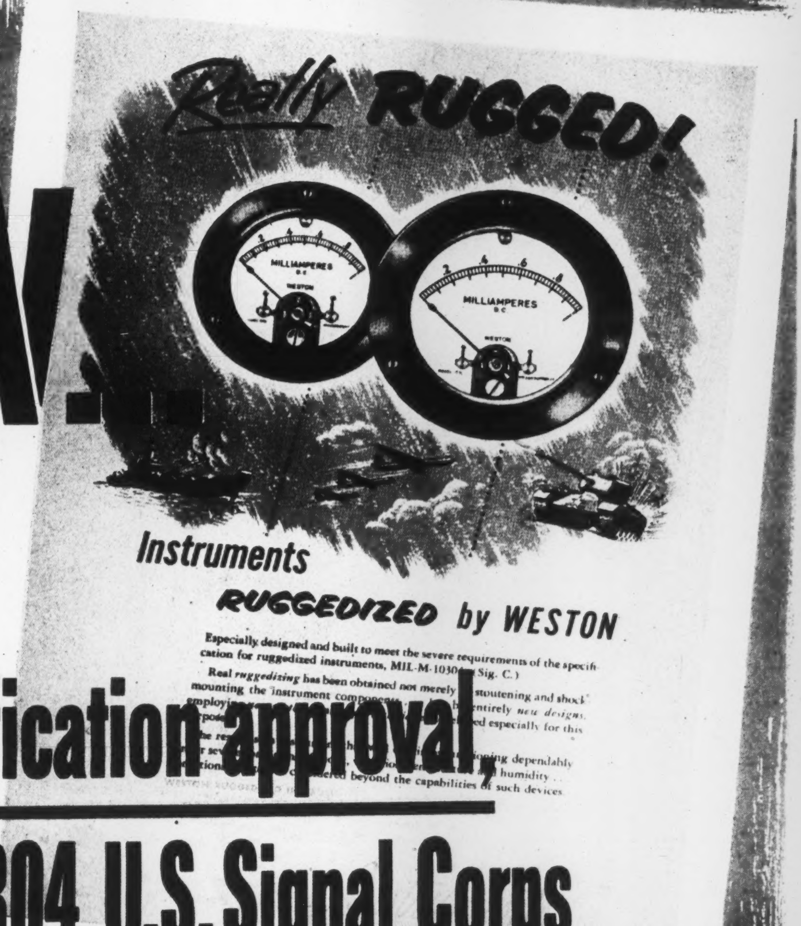
All other countries except those noted below $6.00, $10.00.

For the present, subscriptions not accepted from Austria, Bulgaria, China, Czechoslovakia, Eastern Zone Germany, Hungary, India, Poland, Romania, Russia and Yugoslavia.

Payments from outside the U. S. A. must be in the form of an International Money Order or check on a U. S. Bank.

Position and company connection as well as products manufactured must be indicated in all subscription orders.

NOW...



Instruments RUGGEDIZED by WESTON

Especially designed and built to meet the severe requirements of the specification for ruggedized instruments, MIL-M-10304 (Sig. C.)

Real *ruggedizing* has been obtained not merely [illegible] stoutening and shock mounting the instrument components [illegible] entirely *new designs*, [illegible] especially for this [illegible] functioning dependably [illegible] humidity . . . [illegible] considered beyond the capabilities of such devices

full qualification approval,

MIL-M-10304 U.S. Signal Corps

--Ruggedized Meters

Weston Ruggedized Instruments (Model 1521 Class 52—300 microamperes through 8 milliamperes d-c inclusive) have received full qualification approval from the U. S. Signal Corps under specification MIL-M-10304. For full information contact your local Weston representative or write: Weston Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON RUGGEDIZED INSTRUMENTS

SILECTRON C-CORES... BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

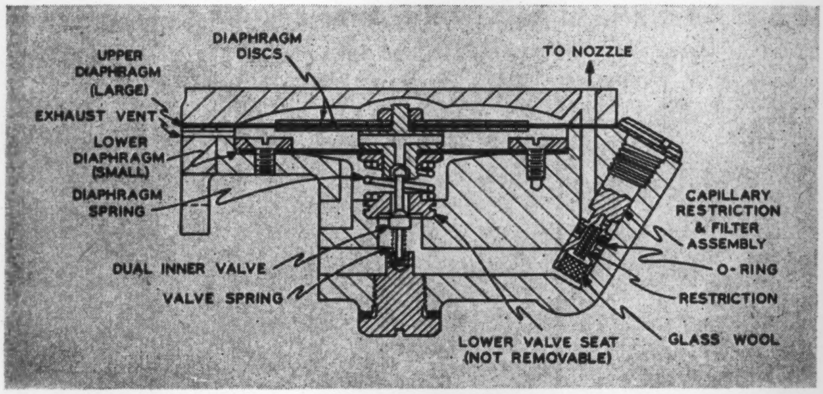
W&D 4363

must have a Superior Relay

you get it in the

P-4 PNEUMATROL

Pneumatic Controller



***HOW IT WORKS:** When flapper is moved against nozzle by measuring system, pressure increases on top of large diaphragm. Floating exhaust seat moves downward pushing lower or inlet valve open increasing pressure in output circuit and under small diaphragm until balance of forces closes the valve. Conversely when nozzle is vented, the diaphragm system moves upward to open exhaust valve, reducing pressure in output circuit until equilibrium is again established.*

The F&P FLOWRATOR meter was the first flow rate meter generally available to exhibit instantaneous response to flow rate change, leading to control problems that have been presented by current mechanical differential type flow transmitters.

Rapid response of the control valve is essential for stable control in a system which changes rapidly. Since the control valve action depends upon the capacity of the relay supplying it with air, the requirement for a high capacity stable relay required solution. Consequently, the P-4 relay has been designed to be extremely fast without impairing its basic sensitivity due to hydrostatic unbalance. The P-4 relay utilizes tandem slack diaphragms which provide the multiple requirements of high capacity, low air consumption "on control", and freedom from all dead zone. Write now for Catalog C-50.

9 POSITIVE BENEFITS

Versatility—one relay fits transmitter, and all case and point-of-measurement controllers.

Integral unit—permits fool-proof construction without tubing connections.

High capacity — essential for best in flow control.
Rated capacity—2 cfm @ 1 psi drop.

Capacity fully usable—transfer switch ports and connectors match relay high capacity.

High force — friction ratio — large diaphragm area produces maximum sensitivity.

Amplification—4:1 pressure multiplication of tandem diaphragms permits low nozzle pressure, low reaction pilot system.

Protected Pilot—integral filter assembly features stainless steel restriction and nozzle.

Non-bleed—no dead zone assured by tandem diaphragm and floating exhaust seat construction.

Materials — aluminum die cast body with brass insert, neoprene diaphragms. Trim, springs and screws of stainless steel.

FLOWRATOR

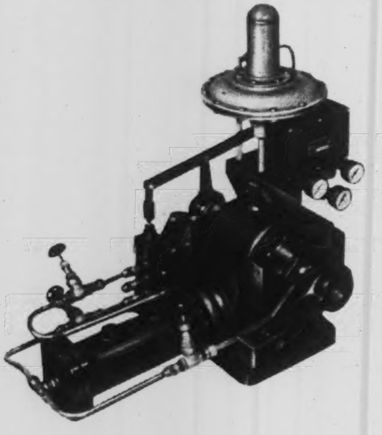
FISCHER & PORTER CO.

1410 County Line Road, Hatboro, Penna.

3 ways

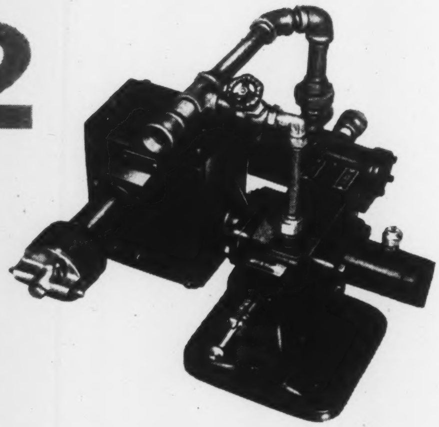
. . . to put hydraulic muscles in a pneumatic control system

1



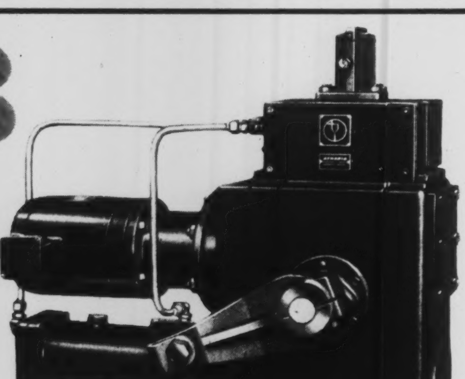
Askania Air-Hydraulic Crank Cylinder, for fast, accurate positioning of butterfly and plug valves.

2



Askania Air-Hydraulic Slide Valve Positioner incorporates the Askania jet pipe relay.

3



Askania Power Unit, with motor, pump, jet pipe relay, and crank cylinder in a compact housing.

YOU CAN operate large valves and dampers fast and positively from a 3-15 p.s.i. air signal. These Askania valve operators *hydraulically* multiply the power you get from air operation. Even with high pressure drops and other difficult conditions, valves are accurately positioned, faster than any other way.

The signal from the pneumatic controller operates only a small hydraulic relay, saving time and air. A feedback mechanism assures a definite, predetermined valve position for any air loading, within 1% of full valve travel. Action is positive in both directions. The equipment is self-lubricated. Hydraulic operation means long life and easy maintenance.

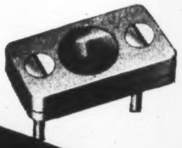
Write for bulletins 1-86, 1-87, and 120, which tell all about these three units.

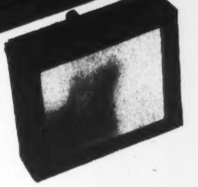
ASKANIA
HY-PERFORMANCE
HYDRAULIC
Controls

ASKANIA REGULATOR COMPANY
240 E. ONTARIO STREET • CHICAGO 11, ILLINOIS
A Subsidiary of General Precision Equipment Corporation

INTERNATIONAL RECTIFIER
CORPORATION

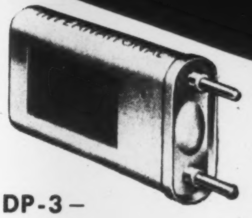
Selenium Photo-Cells





DP-5 –

Hermetically sealed. Window: 1½" x 1½". 600 microamperes at 100 foot-candles illumination. Corrosion-resistant finish. Threaded terminals.



DP-3 –

Hermetically sealed. Window: 9/16" x 3/8". 50 microamperes at 100 foot-candles illumination. Terminals fit standard crystal mounting base. Supplied with corrosion-resistant finish.

STANDARD UNMOUNTED PHOTO-ELECTRIC CELLS

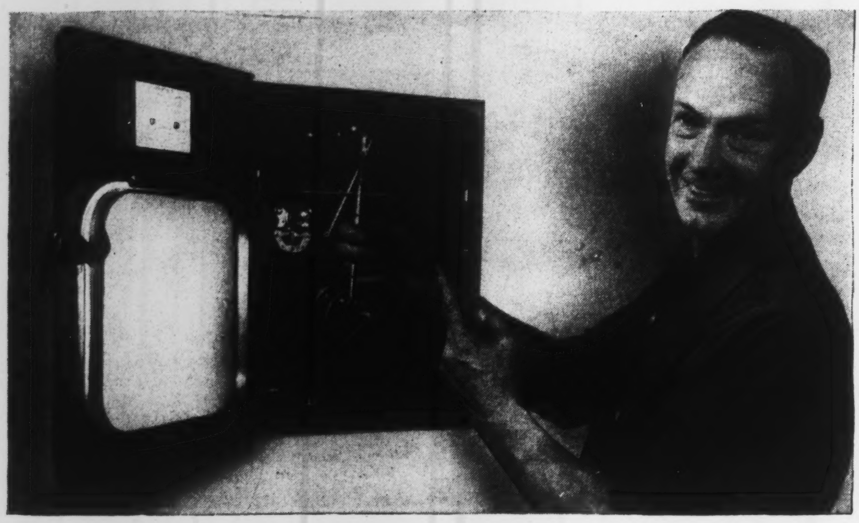
A 15	A 10	A 5	B 10	B 5	B 2
2" diam.	1¾" diam.	1⅛" diam.	1-11/16" x 7/8"	1-7/16" x 41/64"	23/32" x 7/16"
750 microamperes*	500 microamperes*	250 microamperes*	340 microamperes*	220 microamperes*	75 microamperes*

* At 100 foot-candles illumination and 100 ohms external resistance.

INTERNATIONAL RECTIFIER
CORPORATION

General Offices: 1521 E. Grand Ave., El Segundo, Calif. • Phone: El Segundo 1890
Chicago Branch Office: 205 West Wacker Drive • Phone: Franklin 2-3889
New York Branch Office: 12 West 32nd Street, N. Y. 1 • Phone: Chickering 4-0017

No replacement fits a Bristol Instrument so *perfectly* as a Bristol replacement*!



* Who is better equipped than the actual maker of the instrument to make component parts that fit it precisely? Don't risk the lack of precision—which even a slight inaccuracy or misalignment in a component may cause—when you can avoid it so easily by simply specifying Bristol replacements. Quick delivery.

The Bristol Company, Waterbury 20, Connecticut

BRISTOL *The dependable Guidepost of Industry*

How CROSBY's BALANCED AREA DESIGN eliminates back pressure effects

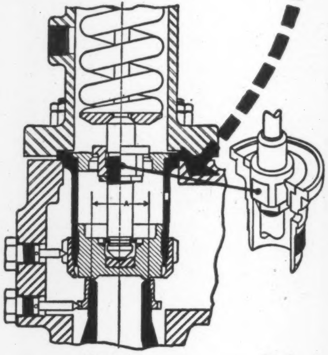


Fig. 1 Fig. 2

When a standard relief valve on gas or vapor service is installed, where back pressure exists, one of two undesirable effects will occur:

Constant Back Pressure — The back pressure acts on part of the upper and the overhanging part of the lower surface of the disc, cancelling out the back pressure force. There remains, however, a force acting on the top portion of disc (area A) which increases the spring load and causes the valve to pop "heavy."

Variable Back Pressure can not be compensated for by spring adjustments. When one or more valves discharge into a common flare header, variable back pressure is placed on the remaining closed valves. This can create a hazardous condition on remaining closed valves, by adding to the spring force. The valve then is prevented from opening until pressure has risen far above the vessel design limit.

[redacted]

is a simple, foolproof method of nullifying these undesirable effects (see Figure 1 above).

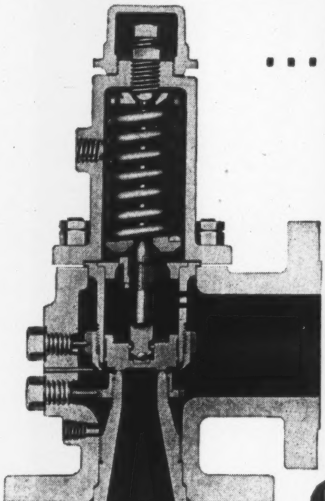
Operation — Crosby achieves *Stable Popping Pressure* by the addition of a piston affixed to the spindle, of area proportioned to equal the unbalanced area of the disc (area A in Fig. 1). Back pressure introduced through the port in the guide then acts on two equal areas in opposite directions, and cancels itself out, neither aiding nor opposing the spring.

To assure full lift and stability, a vent system (see sectional view of piston, Fig. 2) is employed. When the valve is open, the flats on the piston will vent any accumulated back pressure that would tend to close the valve. The adjustment and operating characteristics are similar to the conventional valve. The actual flow into the bonnet is relatively low and can be vented to atmosphere, or through a properly sized discharge header.

Extensive, trouble-free use in the field has proved the success of this Crosby Balanced Area Design.

Here's the [redacted] RELIEF VALVE which eliminates back pressure effects

...and reduces costs!



CROSBY RELIEF VALVE
Style JO-BP
with BALANCED AREA DESIGN
for the elimination
of Back Pressure Effects.

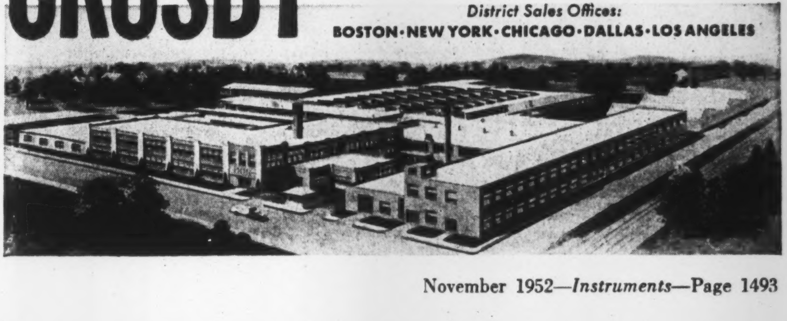
***Proved* ECONOMY!**

On the many installations where Crosby JO-BP Valves have been in operation, refineries report sizable savings in piping costs. The reason—smaller discharge lines made possible by higher back pressure. Since Crosby JO-BP Relief Valves will handle back pressure surges ranging up to 90% of inlet pressure, smaller diameter discharge pipe carries the same amount over the same distance that formerly required much larger pipe.

***Proved* PROTECTION!**

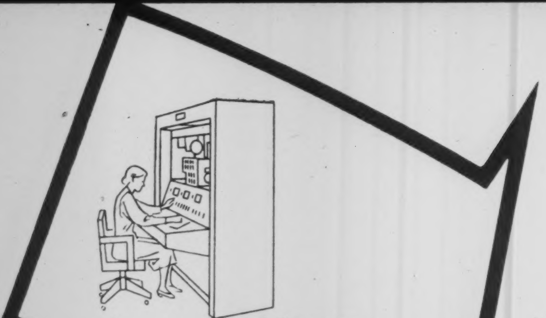
On-the-job performance of Crosby JO-BP Relief Valves proves that you can depend on the vented Balanced Area Design to operate on the set pressure. Thus you are assured of a *Stable Popping Point*. What's more, a full lift is obtained over the normal range of back pressures. The Crosby JO-BP operates with an unrestricted nozzle, follows standard nozzle flow equations for above or below critical ratio as the case may be. With its vented Balanced Area Design, the Crosby JO-BP provides a foolproof, time-tested method of eliminating back pressure effects.

CROSBY STEAM GAGE & VALVE COMPANY
43 Kendrick Street, Wrentham, Mass.
District Sales Offices:
BOSTON·NEW YORK·CHICAGO·DALLAS·LOS ANGELES

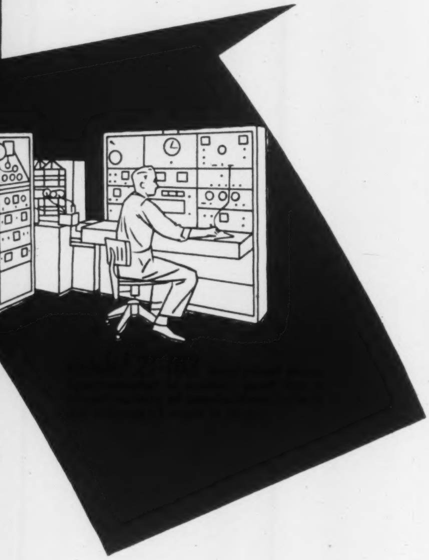


mass spectrometer

priced right for laboratories having moderate analytical loads



model 21-201 Isotope-Ratio Mass Spectrometer, a special purpose instrument for measuring ratios of stable isotopes in gases.



model 21-401 serves as a combination analytical and isotope-ratio mass spectrometer.

CONSOLIDATED Model 21-401, the newest member of Consolidated's family of mass spectrometers, is a compact, medium-price instrument, ideal for those laboratories having moderate analytical loads. It provides (1) automatically recorded mass spectra for quantitative analyses of gaseous or light-liquid mixtures, and (2) precise, *recorded* ratios of stable gaseous isotopes. Like the widely used Model 21-103, it is exceptionally accurate and incorporates many automatic, time-saving features. For the multitude of industrial and scientific applications not requiring extremes of mass range, sensitivity, and operating speed, the Model 21-401 is of maximum value. Write for Bulletin CEC-1821.

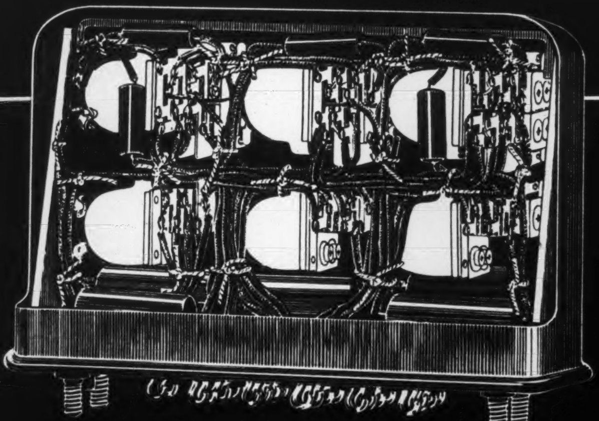
ANALYTICAL SERVICE—here to serve you if your analysis requirements do not justify the purchase of an instrument. This precision analytical laboratory service has been operated at the Consolidated factory in Pasadena since 1949—utilizing mass spectrometry under the supervision of Consolidated's experienced staff. For cost, handling of samples and other details, request Bulletin CEC-1813.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

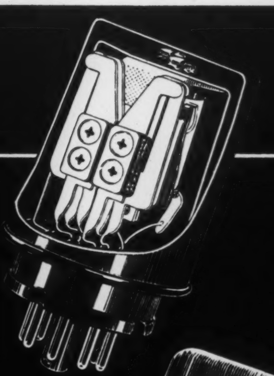
Sales and Service through **CEC INSTRUMENTS, INC.**
a subsidiary with offices in: Pasadena, Philadelphia, Chicago, Dallas.

analytical instruments for science and industry

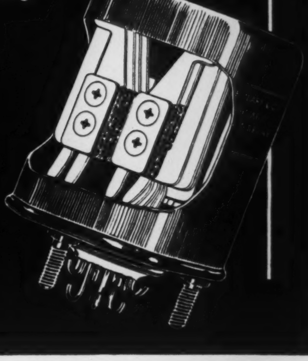
CLARE offers the widest variety of HERMETICALLY SEALED RELAYS for most exacting design requirements!



Considerable cost and space can often be saved by sealing more than one relay in an enclosure. Illustration shows six CLARE Type "K" relays, associated resistors and capacitors, wired and mounted in a common enclosure.



Here is one of over 300 plug-in relays in the CLARE SK-5000 series.



CLARE Type "N" relay in a Series SN-41000 container.

What CLARE Hermetic Sealing Means:

After assembly in the container, the enclosure is attached to a high vacuum pump and pumped down to a few microns pressure to remove all traces of moisture and gases, then flushed with dry nitrogen, and again pumped down.

While under this extreme vacuum, the enclosure and seals are tested for leaks by means of a Mass Spectrometer—a device so sensitive that it can detect a leak so tiny that more than thirty-one years would be required for one cubic centimeter of air to pass through it. This highly refined method of leak testing causes rejection of many enclosures which could pass the usual immersion tests without detection.

For most applications, the enclosure is then filled with dry nitrogen, which has a relatively high arcing potential.

IN THE fourteen years since CLARE first began the development of hermetically sealed relays for airborne, military and industrial use, CLARE has developed over 50 different series of hermetically sealed relays.

Each series varies in the size of the container, the number and kind of terminals, mounting facilities and the type or types of relays which can be sealed in it. Within each series, innumerable variations of relay coil and contact specifications are possible.

Two things, however, never vary: the high quality of the CLARE relay which goes into each enclosure and the completely airtight sealing which permits no gas or spirit to escape from the enclosure or enter it.

If your product requires the use of hermetically sealed relays, CLARE can supply you just the relay you need from this wide variety, or will develop and seal for you a special, "custom-built" relay to meet your most exacting requirements.

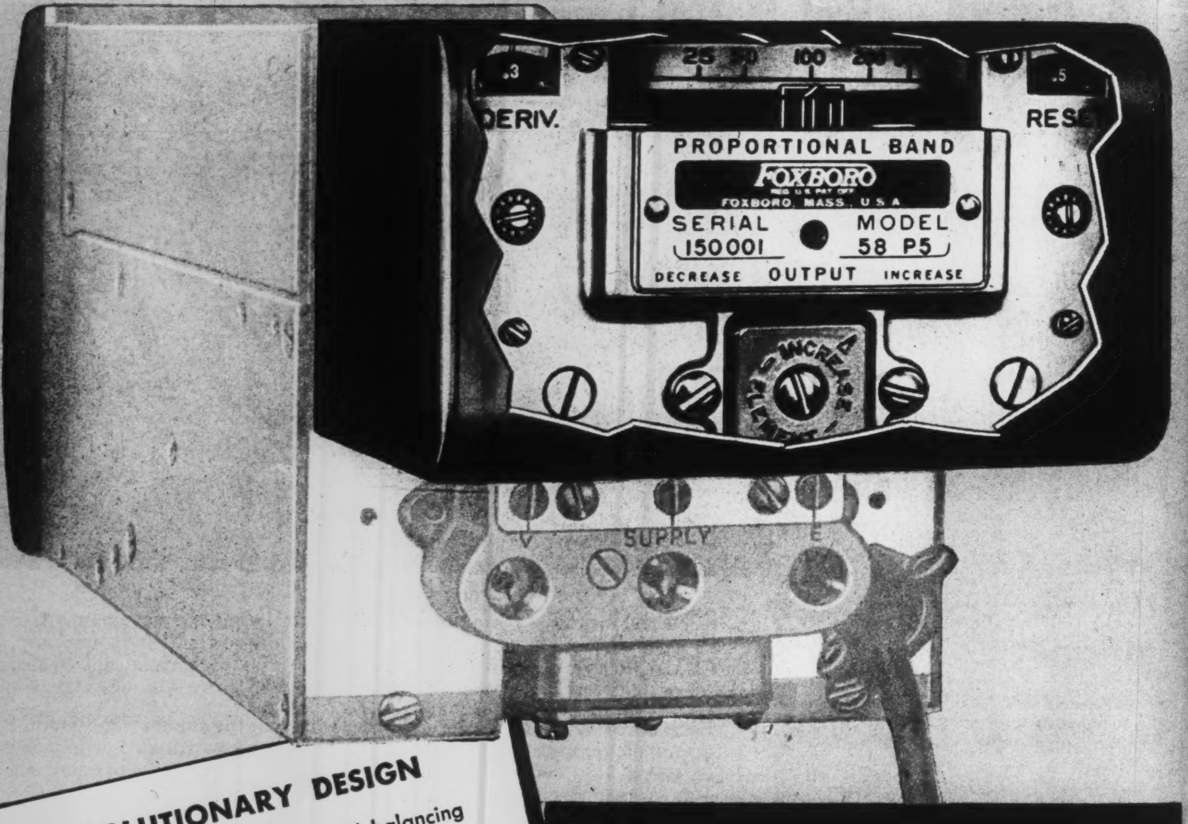
Send for CLARE BULLETIN NO. 114 on Hermetically Sealed Relays or contact the nearest CLARE sales engineer for complete information. Address: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Co., Ltd., Toronto 13. Cable address: CLARELAY.

CLARE RELAYS

...First in the Industrial Field

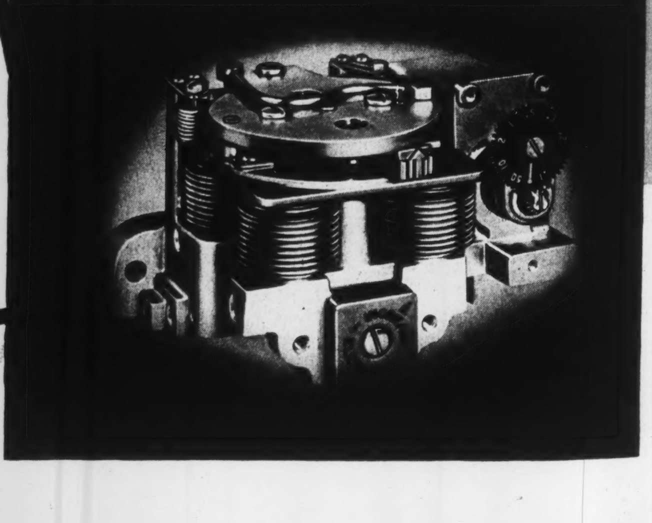
The New CONSOTRO

Radically new operating principle . . . Simplest Installation


25
50
100
200
DERIV.
RESET
PROPORTIONAL BAND
FOXBORO
FOXBORO, MASS. U.S.A.
SERIAL
150001
MODEL
58 P5
DECREASE
OUTPUT
INCREASE
INCREASE
SUPPLY
V
E

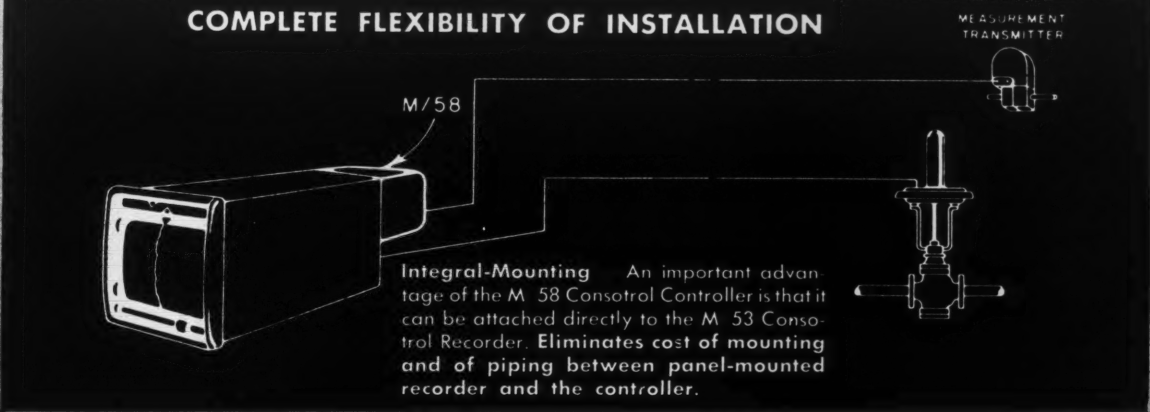
REVOLUTIONARY DESIGN

The unique Foxboro "floating-disc" balancing system is shown at right with dial-set reset unit. Dial-set derivative unit is plugged in at left of assembly (see above). Conversion from proportional to reset and/or derivative action can be made in the field, in a matter of moments, with only a screwdriver! New design adjustable restrictors provide 1000-1 rangeability, perfect reproducibility, and consistent rates on both increasing and decreasing air pressure. Proportional band is a lever setting, fully adjustable from 0 to infinity.

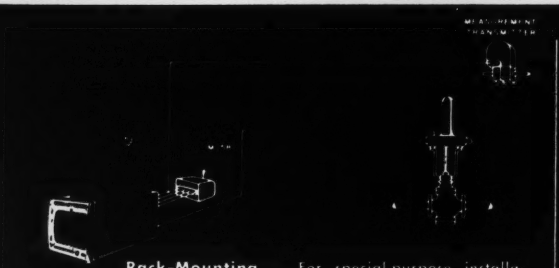


M/58 CONTROLLER

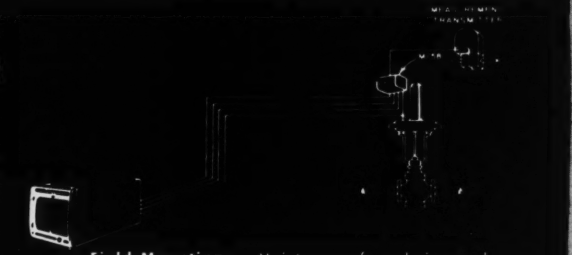
COMPLETE FLEXIBILITY OF INSTALLATION



Integral-Mounting An important advantage of the M/58 Consotrol Controller is that it can be attached directly to the M/53 Consotrol Recorder. **Eliminates cost of mounting and of piping between panel-mounted recorder and the controller.**



Rack-Mounting For special-purpose installations, the M/58 Controller can be rack mounted and piped to the M/53 Consotrol Recorder or comparable unit.



Field-Mounting Maintenance-free design and weatherproof, all-metal construction readily permit this usage when the process requires it.

Over and above its extreme compactness for graphic panel use, the new Foxboro M/58 Consotrol Controller offers unique advantages in its simplicity of design, unmatched performance, and ease of installation.

This Controller employs an exclusive, simplified balancing system in which the measurement, proportional, reset, and derivative bellows act on a single "floating-disc". With no diaphragms, only one nozzle, and only one moving part, it gives control action unrivalled in stability, sensitivity, and with positive, drift-free control point.

Installation, also, is radically simplified. The M/58 is designed to attach directly to the M/53 Consotrol Recorder (eliminating cost of piping and mounting) or, optionally, to be mounted in remote locations if required.

Write for Bulletin 463 containing full details of the M/58 Controller together with the full line of Consotrol Instruments. **The Foxboro Company, 4611 Neponset Avenue, Foxboro, Massachusetts, U. S. A.** Branches in principal cities.

FOXBORO instruments

Reg. U.S. Pat. Off.

INDICATING • RECORDING • CONTROLLING

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

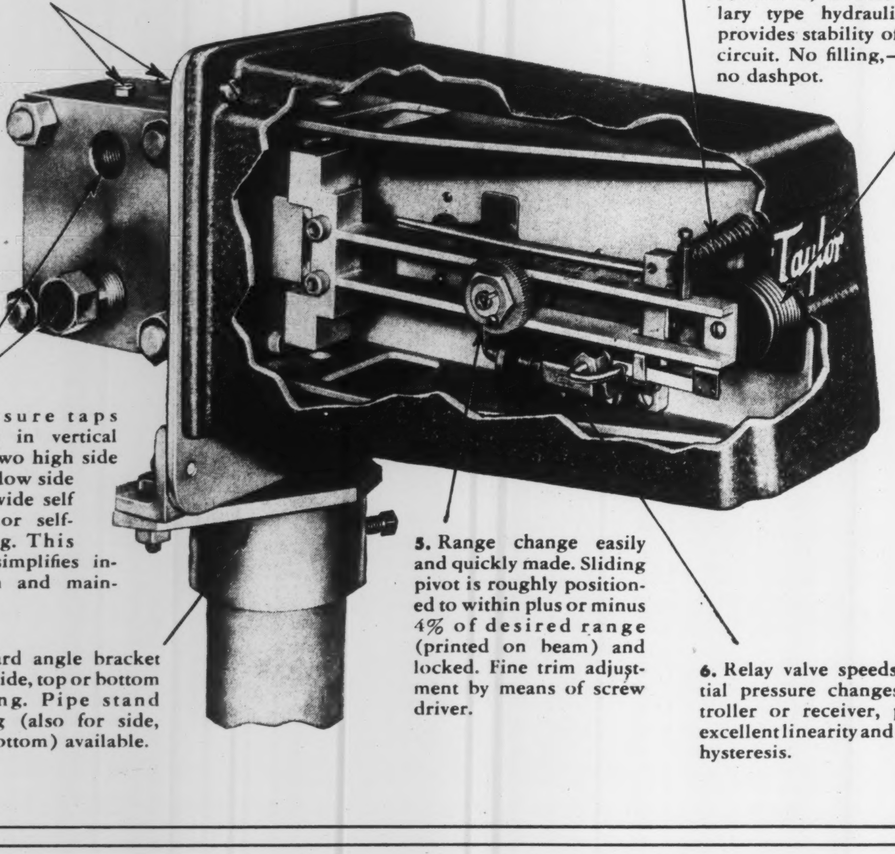
Taylor announces

1. Dry meter operates on force-balance principle. Diaphragm of Teflon coated glass cloth. Body working pressure rating 1500 psi. Available in either forged steel or type 430 stainless steel.

2. Vent screws to provide for total filling in liquid service.

8. Provision for adjustment of range suppression up to 100%.

7. Built-in, trouble-free, capillary type hydraulic damping provides stability of pneumatic circuit. No filling,—no mess—no dashpot.

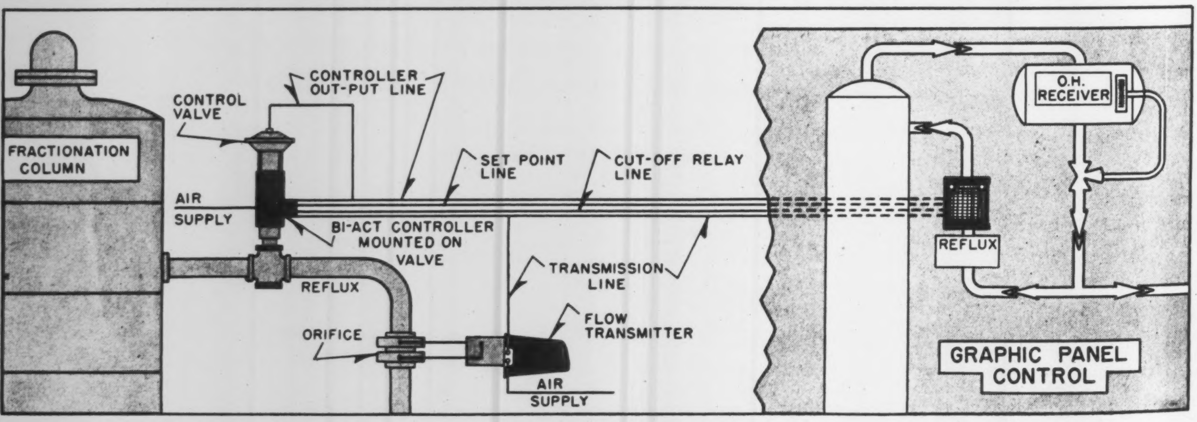


3. Pressure taps mounted in vertical plane. Two high side and two low side taps provide self venting or self-draining. This feature simplifies installation and maintenance.

4. Standard angle bracket permits side, top or bottom mounting. Pipe stand mounting (also for side, top or bottom) available.

5. Range change easily and quickly made. Sliding pivot is roughly positioned to within plus or minus 4% of desired range (printed on beam) and locked. Fine trim adjustment by means of screw driver.

6. Relay valve speeds differential pressure changes to controller or receiver, providing excellent linearity and minimum hysteresis.


FRACTIONATION COLUMN
CONTROL VALVE
CONTROLLER OUT-PUT LINE
SET POINT LINE
CUT-OFF RELAY LINE
AIR SUPPLY
BI-ACT CONTROLLER MOUNTED ON VALVE
REFLUX
TRANSMISSION LINE
ORIFICE
FLOW TRANSMITTER
AIR SUPPLY
O.H. RECEIVER
REFLUX
GRAPHIC PANEL CONTROL

SIMPLIFIED FLOW MEASUREMENT

With the NEW Taylor TRANSAIRE®
Differential Pressure Transmitter

INEXPENSIVE AND SIMPLE TO INSTALL

1. Simplified piping because it can be close coupled to orifice flanges.
2. No leveling—mercuryless dry meter.
3. Side, top or bottom bracket mounting; available with 2″ pipe stand.
4. No seal pots required—negligible displacement because of force balance construction.
5. Light weight for easy handling; weighs only 23 lbs.
6. Vent screws for simple, solid filling.

ECONOMICAL—EASY TO MAINTAIN

7. Self draining or venting—no periodic manual venting or draining.
8. Mercuryless — flexible but tough Teflon coated glass fabric diaphragm.
9. Overrange protection to full body rating.
10. Purges, if required, can be installed to keep body swept clean.
11. Simple range change by sliding pivot—screw driver trim.

ACCURATE

12. Relay valve for linearity, minimum hysteresis, fast speed of response.
13. Pressure effect 0.2% / 100 psi. change.
14. Temperature effect 1.0% / 100°F. change.
15. Self draining and venting. No errors build up during operation.
16. Damped pneumatic circuit—stable air output even on vibrating pipe lines.

RUGGED AND DEPENDABLE

17. Body forged steel or type 430 Stainless Steel. Working pressure rating, 1500 psi.
18. Weather proof housing built for tough service and outdoor mounting.
19. Force balance construction—negligible motion—minimum possible wear.
20. Process sealing bellows 3-ply type 316 stainless steel.

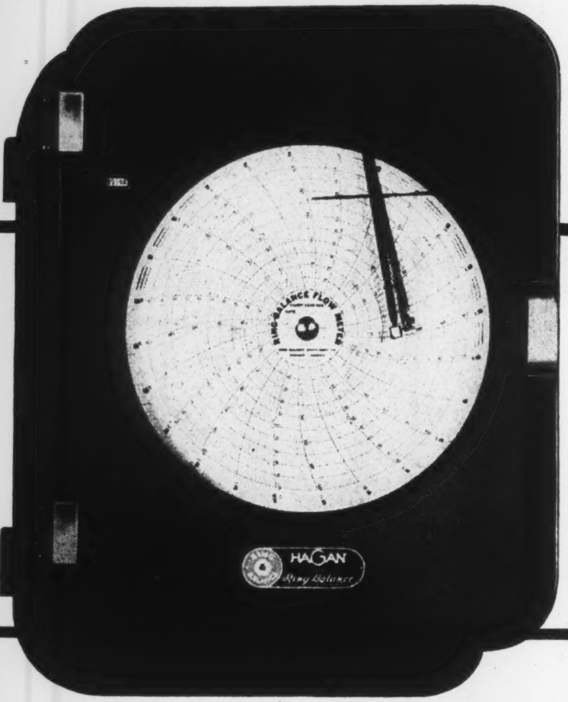
ADAPTABLE

21. 100% suppression—continuously adjustable from 0 to 100%. Ideal for liquid level applications.
22. Ten-to-one rangeability in each of two forms: a. 20-200″ water b. 80-800″ water.

Find out more about this new flow and liquid level transmitter. Ask your Taylor Field Engineer, or write for **Bulletin 98226.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

When you specify
HAGAN RING BALANCE FLOW METERS
you are buying



- ★ **DEPENDABILITY**
- ★ **VERSATILITY**
- ★ **ACCURACY**

features of HAGAN RING BALANCE METERS include:

- **No stuffing boxes or pressure-tight bearings**
- **Excellent response at extremely low flow rates**
- **Mercury level not critical**
- **Ease of dead-weight calibration**

Hagan Ring Balance Meters are simple in design, rugged in construction. Whatever your metering problems, our engineers are at your service. For full information, get in touch with

HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH 30, PENNSYLVANIA

HAGAN
HALL
BUROMIN
CALGON

Hagan Corporation
Hagan Building • Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters.

I am particularly interested in . . . .

. . . .

NAME . . . .

POSITION . . . .

COMPANY . . . .

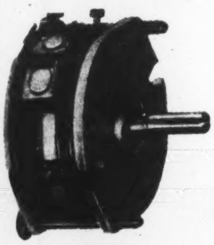
STREET AND NUMBER . . . .

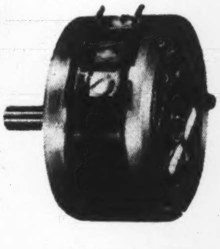
CITY . . . . ZONE . . . . . STATE . . . .

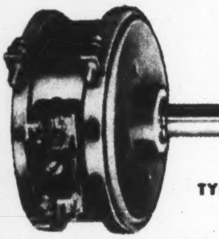
I-11

Potentiometer accuracy improved!

Fairchild Precision Potentiometers now offer greater accuracy and longer life than ever before


TYPE 736


TYPES 747 and 748


TYPE 746

Experience with Fairchild Precision Potentiometers in hundreds of applications shows that these units far exceed their original guaranteed tolerances. As a result, accuracies of ±1% in non-linear types and as high as ±0.05% in linear types can be guaranteed. Service life as high as 10,000,000 cycles, under certain conditions, also can be provided. High resolution, low torque, and low noise level are other performance features worth noting.

Fairchild Precision Potentiometers perform mathematical computations in electrical computing systems for machine-tool controls, process controls, telemetering, guided missiles, flight control, fire control, and analog computers of all types. They are available in non-linear and linear types and in ganged combinations of either or both with windings to meet your requirements.

If you want *accuracy* in your control systems, ask about Fairchild Precision Potentiometers.

SPECIFICATIONS OF FAIRCHILD PRECISION POTENTIOMETERS (Nominal Values)

	TYPE 736	TYPE 746	TYPE 747	TYPE 748
Resistance Range, ohms				
Linear (standard), min.	680 ±3% **a**	680 ±3% **a**	3,000 ±5% **a**	5,000 ±5% **a**
max.	115,000 ±3% **a**	115,000 ±3% **a**	100,000 ±5% **a**	150,000 ±5% **a**
Linear (special), min.	85 ±3% **a**	85 ±3% **a**	50 ±5% **a**	80 ±5% **a**
max.	145,000 ±3% **a**	145,00 ±3% **a**	115,000 ±5% **a**	200,000 ±5% **a**
Non-Linear	**b**	**b**	—	—
Electrical Function Angle, deg.	320 nominal	320 nominal	351.3 ±0.5	354.5 ±0.5
Electrical Contact Angle, deg., max.	340	340	351.3 (+4, −0)	354.5 (+4, −0)
Mechanical Rotation	Continuous	Continuous	Continuous	Continuous
Functional Tolerance (guaranteed), per cent				
Linear, Some Non-Linear	±0.50 **c**	±0.50 **c**	±0.15 **d**	+0.10 **e**
Other Non-Linear	±1.00	±1.00	—	—
Mechanical Accuracy				
Concentricity (shaft to pilot bushing), in., FIR max.	0.0025	0.0010	0.0025	0.0025
Radial Shaft Play, in., max.	0.0015	0.0009	0.0015	0.0015
Shaft, dia., in.	Centerless ground stainless steel to 0.2500 (+0.0000, −0.0005 in.)	Centerless ground stainless steel to 0.2497 (+0.0000, −0.0002 in.)	Centerless ground stainless steel to 0.2500 (+0.0000, −0.0005 in.)	Centerless ground stainless steel to 0.2500 (+0.0000, −0.0005 in.)
Pilot Bushing, dia., in.	Machined to 0.5000 (+0.0000, −0.0005 in.)	Machined to 0.5000 (+0.0000, −0.0005 in.)	Machined to 0.7500 (+0.0000, −0.0005 in.)	Machined to 0.7500 (+0.0000, −0.0005 in.)
Torque, oz.-in. per cup	2.0	1.5	1.0	1.0
Wattage (rated at 40 C ambient temperature)	2.5	2.5	4	5
Terminal Voltage, max.	400	400	400	400
Voltage Breakdown at Sea Level (60 cycle) RMS	900	900	900	900
Taps, number per cup	9 **f**	1 **fg**	12 **h**	16 **h**
accuracy of location, deg.	±1	±1	±1	±0.5
width, deg., max.	1.00 **i**	1.00 **i**	0.75 **i**	0.60 **i**
Ganging on Single Shaft, max.	5	20	10	10
Operating Ambient Temperature Range, deg. C	−55 to +71	−55 to +71	−55 to +71	−55 to +71
Service Life, cycles, max.	5,000,000 **j**	5,000,000 **j**	10,000,000 **j**	10,000,000 **j**
Dimensions, in.				
Diameter	1.899	1.750	2.093	3.093
Length (one cup), max.	0.795	0.800 ±0.009	1.156	1.156
Added Length Per Unit Ganged	0.609	0.580 ±0.002	0.594	0.594

a Tolerance on both linearity and over-all resistance may vary or be improved depending on resistance value required.

b Maximum resistance range depends on requirements. Tolerance on over-all resistance of non-linear windings is ±5%.

c Linearity up to ±0.30% on the higher resolution windings by special order.

d Linearity up to ±0.10% on the higher resolution windings by special order.

e Linearity up to ±0.05% on the higher resolution windings by special order.

f By adding dummy cup section, 19 taps can be provided.

g Two taps can be provided by slight design modification using terminal board clamp screw modified for wiper terminal.

h Depending on spacing requirements and without moving bridge or wiper terminal.

i Varies with resolution.

j Life will be guaranteed depending on specific potentiometer required.

SAMPLE POTENTIOMETERS IN A HURRY! **Send your potentiometer problems to the Fairchild Potentiometer Sample Laboratory and we'll show you how to solve them. Sample units can be designed and built at nominal cost in 4 to 6 weeks after receipt of approved specifications. For full details write to *Potentiometer Division, Fairchild Camera and Instrument Corporation, Park Avenue, Hicksville, Long Island, New York, Department 140-30B.***

FAIRCHILD
PRECISION POTENTIOMETERS

Specify **CHESTER**

plasticord-plasticote

WIRES and CABLES

JAN-C-76 WIRES SRIR* SRHV* SRRF* WL*

80°-90° 105°C UL APPROVED WIRES*

SHIELDED WIRES and CABLES

FLEXIBLE CORDS

TELEVISION LEAD-IN WIRES

COMMUNICATION WIRES and CABLES

COAXIAL CABLE

INSTRUMENT WIRES

WIRES and CABLES to SPECIFICATION

*Solid Colors or Spiral Marking

Everything in wiring

More and more—engineers, designers, production men and purchasing officials have come to regard Plasticord and Plasticote Wires and Cables by Chester as the standard of comparison. This is because every inch of these dependable insulated conductors is made to conform to exacting quality controls that assure long service life, and performance as specified by the factory. That's the reason electrical men, everywhere, look for the Chester trademark when they're looking for the best!

"Chesty" **says—**

Our new catalog is a complete guide to plastic insulated wire and cable for every purpose. Write for a copy of this important data compilation for your files today.

CHESTER CABLE CORP.
CHESTER, NEW YORK

MANUFACTURERS OF QUALITY WIRES AND CABLES FOR EVERY REQUIREMENT

INSTRUMENTS FOR LABORATORIES

G-E Photolight is Used in Supersonic Speed Studies At University of Maryland

Bullets in flight at speeds from 1120 to 4000 fps are photographed with the help of a General Electric Photolight at the ballistics range in the aeronautical laboratory at the University of Maryland.

LIGHT BEAM TRIPPED

When the projectile intercepts a cross beam of light, the photolight is tripped and the exposure is made by an open-shutter camera.

HIGH INTENSITY FLASH

The photolight provides an extremely high intensity flash of blue-white light with a duration of approximately one microsecond. This photolight is also used to study fluid flow, vibration, and high speed rotational and linear motion. Check coupon for GEC-337. Price of Photolight is $751.50*.

*Mfg. suggested retail price.

1952 CATALOG

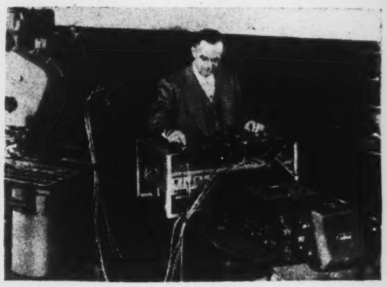
G-E Measuring Equipment

80 pages describing all of General Electric's testing and measuring devices. For free copy check GEC-1016 in coupon at right.

MEASURING EQUIPMENT

Costly Production Problems Solved with G-E Oscillograph

The United Shoe Machinery Corporation's research division gets the answers to timing and strain design problems by using General Electric PM-10 oscillographs.



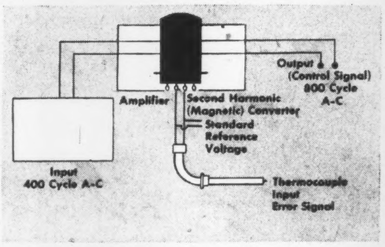
PM-10 USED WITH STRAIN GAGES

A lever and cam system on their new Welt Butting and Tacking Machine, Model B, was breaking and causing high maintenance expense. In order to find the cause of the trouble, a six channel a-c strain gage amplifier was used in conjunction with a PM-10 oscillograph to record the strains while the machine was operating normally. The answers obtained enable USMC engineers to quickly solve this important field service problem.

RECORDS MANY QUANTITIES

Designed to meet the wide field of applications for a twelve-element oscillograph, the Type PM-10 can be used to make simultaneous records of voltage, current, time, pressure, speed, stress, strain, sound, vibration, etc. Viewing while a record is being made is possible. Timing lines can be recorded directly on the film. Prices start at $4000.00 for the complete equipment. For more information check coupon for bulletin GEC-449.

COMPACT SECOND-HARMONIC CONVERTER IS USEFUL IN MANY CONTROL SYSTEMS


Output (Control Signal) 800 Cycle A-C
Amplifier
Second Harmonic (Magnetic) Converter
Standard Reference Voltage
Input 400 Cycle A-C
Thermocouple Input Error Signal

A completely static device, the General Electric second-harmonic converter converts small d-c signals, such as a thermocouple output, to an a-c voltage.

Designed mainly for use with 400 cycle excitation, this magnetic amplifier converts low level d-c error signals to an 800 cycle output.

RELIABLE OPERATION

Especially well suited for aircraft and guided missile applications because it is static and hermetically sealed, the converter has a long life even when operated continuously under extreme conditions of acceleration, temperature, pressure, and humidity. For additional information check coupon for bulletin GEC-832 or contact your nearest G-E apparatus office.

SECTION B605-26, GENERAL ELECTRIC
SCHENECTADY 5, N. Y.

Please send me the following bulletins: Indicate:

√ for reference only
X for planning an immediate project

- ☐ Photolight GEC-337
- ☐ Oscillograph GEC-449
- ☐ Second-harmonic Converter GEC-832
- ☐ 1952 Catalog GEC-1016

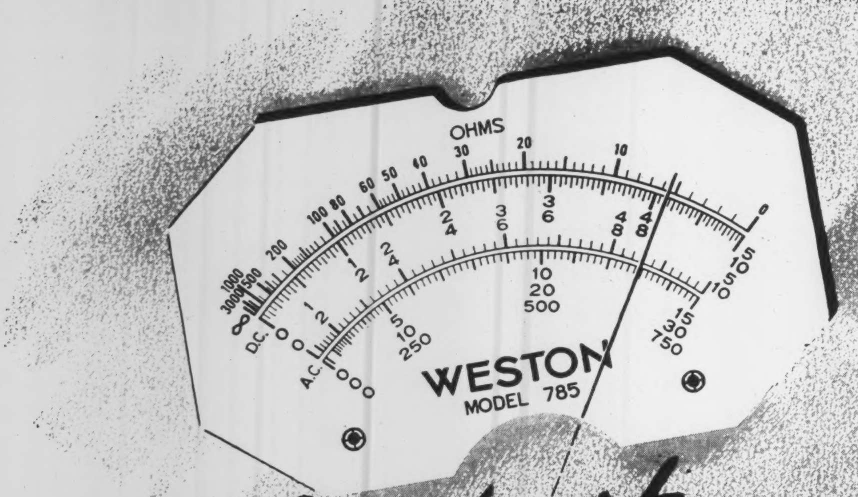
NAME..

COMPANY..

STREET..

CITY.......................ZONE.......STATE.........

GENERAL ELECTRIC



#785 Checks them all!

ELECTRONIC EQUIPMENT— used increasingly throughout industry for sensitive indicating and control applications.

CONTROL CIRCUITS— whether built into your products, used in your processing, or rigged up in the lab.

MOTORS, GENERATORS— as well as relays, transformers, and similar electrical mechanisms.

ELECTRICAL DEVICES— of all sorts...either at the test bench or right in the shop.

● Yes, you can check just about any circuit from sensitive electronic equipment to electrical motors with this Weston Model 785 Industrial Circuit Tester. Here, in one case, is all the equipment you need for most circuit testing:

D-C VOLTS: 0.1/1/10/50/200/500/1000 volts.
A-C VOLTS: 5/15/30/150/300/750 volts.
D-C CURRENT: 50 microamps; 1/10/100 milliamps; 1/10 amps.
A-C CURRENT: .5/1/5/10 amps.
RESISTANCE: 0-3,000/30,000/300, 000 ohms; 3/30 megohms.

Other features not available in testers of this type include: unlimited current measurements with the use of external transformers or shunts—voltage and current circuits completely isolated to provide greater flexibility and meter protection—potential and current connections can be made simultaneously. 'Phone your local WESTON Representative, or write—WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey.

WESTON *Instruments*

PIPE LINE FILTER
STAYNEW
CORPORATION

Staynew Pipe Line Filters *help* *Taylor Instrument Companies* maintain High Quality, Accuracy...

One of a battery of Staynew Pipe Line Filters keeping impurities out of process compressed air at the Taylor Instrument Companies, Rochester, N.Y.

Pictured is part of an assembly line at the Taylor Instrument Companies where highly skilled technicians use compressed air to form the bulbs of precision fever and industrial thermometers. Impurities, no matter how minute, are kept from entering the .002″ bore to maintain high quality control. That's why the Staynew Model CPH-03 Pipe Line Filter is standard equipment at every bench.

Staynew's basic design first eliminates larger particles mechanically. Then, finer air-borne material is removed by the radial fin filter insert. This double action principle reduces the load on the insert making frequent cleanings unnecessary.

There can be no compromise with quality. Millions of thermometers will pass through the Taylor production lines this year where *Accuracy First* is the watchword. Wherever used, Staynew Filters give day in and day out dependable service with low maintenance cost.

Send for Pipe Line Filter Bulletin B-1A

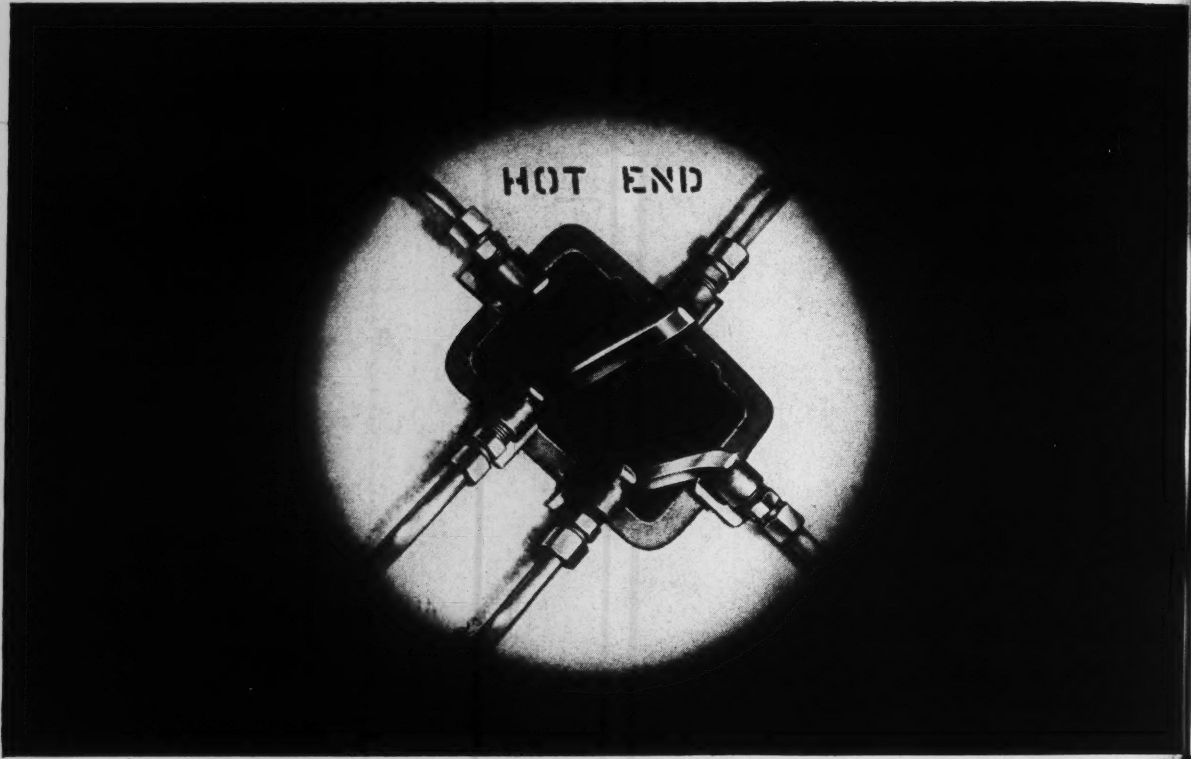
Representatives in Principal Cities

DOLLINGER
PROTECTOMOTOR
REG U.S. PAT. OFF.
STAYNEW FILTERS

DOLLINGER CORPORATION

63 Centre Pk., Rochester 3, N. Y.

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED



The Superior Tube That Keeps Its Temper In A Hot Spot

Producing tubing and tubular parts that stand up well even when the heat's on is a Superior specialty.

One of these parts is shown above. It is a guide rail for a TOCCO† induction hardening furnace, manufactured by The Ohio Crankshaft Co., a Superior customer.

This simple tube has to be tough. Constantly exposed to high heat, it must retain its temper, stay hard. Continually abraded by the scrubbing action of the 25 pound hot-rolled steel slugs that ride along it, it must require infrequent replacement. In addition it must not crack when brazed, or develop cracks in use.

Reading this list of requirements would suggest that the guide rail must necessarily be a brute-strong, thick-walled, heavy-weight. It isn't—it is a ⅜″ square Inconel* tube with a wall only .065″ thick. It is another example of fine, small tubing that does a big job well.

Producing it presented a problem—but just the type of problem we like to meet and can almost always solve. We have the right combination of engineering, research and production facilities that makes it easy for us to work closely with our customers' designers and engineers, and to produce the tubing required to fit the most exacting specifications.

If you use small tubing and have a problem it might be well to check with us. We can probably help and will be glad to do so. Write Superior Tube Company, 1968 Germantown Ave., Norristown, Pennsylvania.

BE SURE ABOUT TUBING—SPECIFY Superior

THE BIG NAME IN SMALL TUBING

All analyses .010″ to ⅝″ O.D.
Certain analyses (.035″ max. wall)
up to 1⅜″ O.D.

West Coast: Pacific Tube Company, 5710 Smithway St.
Los Angeles 22, Calif. UNderhill O-1331

ROUND AND SHAPED TUBING

Available in:

Carbon Steels:
A.I.S.I.—C-1008, MT-1010, MT-1015, C-1118, MT-1020, C-1025, C-1035, E-1095

Alloy Steels:
A.I.S.I.—4130, 4132, 4140, 4150, 8630, E-52100

Stainless Steels:
A.I.S.I.—303, 304, 305, 309, 310, 316, 317 321, 347, 403, 410, 420, 430, 446, T-5

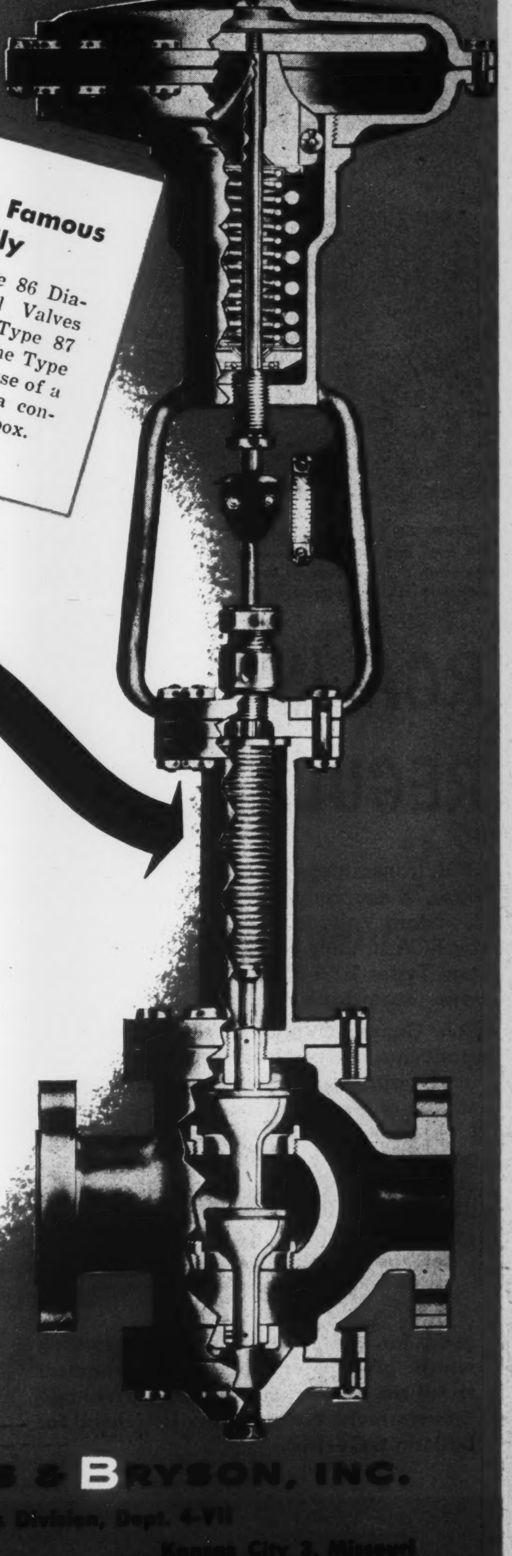
Nickel Alloys:
Nickel, "D Nickel"*, "L Nickel"*, "Monel"*, "K Monel"*, "Inconel"*, 30% Cupro Nickel.

Beryllium Copper

*Reg. U.S. Trademark—International Nickel Co.
†Reg. U.S. Trademark—The Ohio Crankshaft Co.

AKE NO CHANCES WITH SLIGHT LEAKAGE

APPLICATION: Where even slight leakage of a flowing medium might become obnoxious, dangerous or excessively expensive.



From The Famous Family

of Climax Type 86 Diaphragm Control Valves . . . the NEW Type 87 . . . identical to the Type 86 except for the use of a bellows seal plus a conventional stuffing box.

Specify

BS&B CLIMAX

Type 87 Diaphragm Control Valves

. . . with bellows sealed stem

Constantly striving to improve an already satisfactory item—that's part of the BS&B policy, part of our way of doing business. For example, take BS&B Climax Type 86 Diaphragm Control Valves of which the Type 87 is a family member. All Climax Type 87 valve bodies are designed to conform to I. S. A. tentative face-to-face standards. New designs continue to feature BS&B's interchangeability-of-parts advantage for greater operating and maintenance economy.

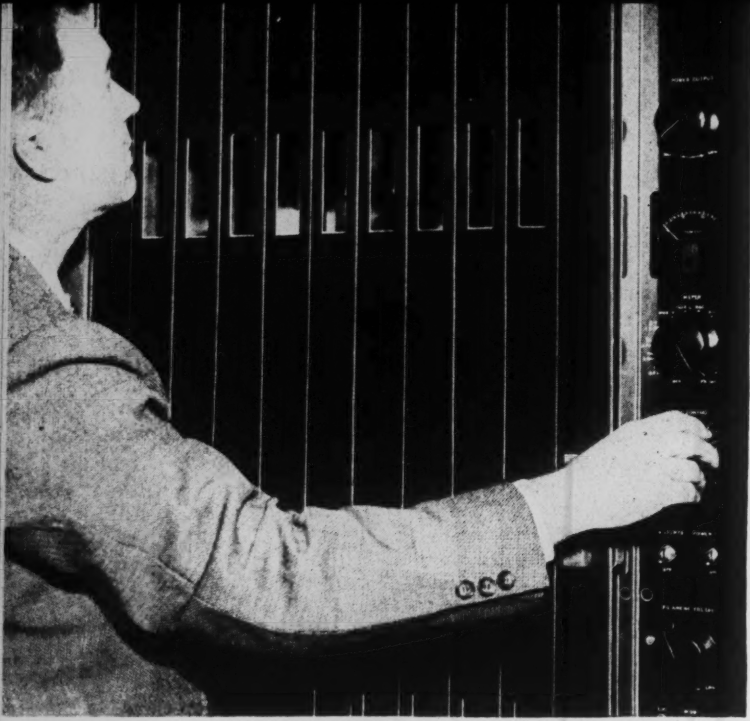
Type 87 is manufactured for all services and in all materials that are contemplated by Type 86 and in sizes from ½" to 6". Bellows can be supplied in bronze, stainless steel, Monel, Hastelloy "B", Nickel or other special alloys suitable. Maximum working pressure 400 lbs. cwp. The conventional teflon packed stuffing box is installed at the point the valve stem passes out of the bellows casing to forestall any appreciable loss of flowing medium in case of bellows failure.

Ask your BS&B MAN...33 Branches...13 Sales Offices...Ask for New Climax Catalog Section 105—recently revised—or write Black, Sivalls & Bryson, a leader for 60 years in oil and gas producing and refining equipment...out in front with controls and equipment for the processing industries.

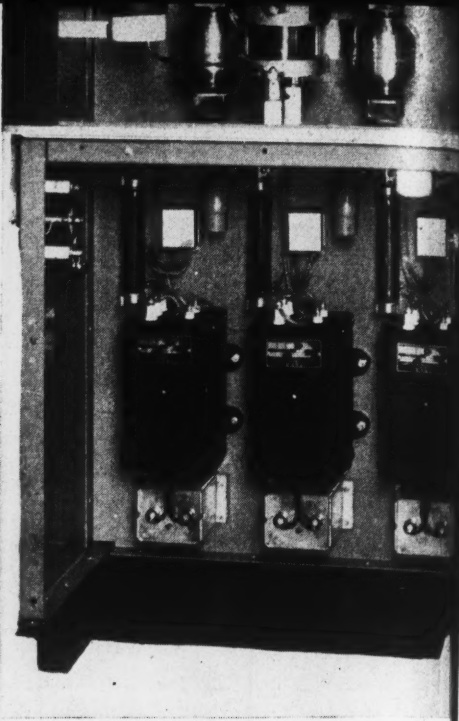
CLIMAX
BS&B
CONTROLS

BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division, Dept. 4-VII
7500 East 12th St. Kansas City 3, Missouri



TUNING AN RCA TRANSMITTER. **This AM broadcast transmitter is the ultimate in engineering. It's easy and simple to operate . . . compact . . . high in fidelity . . . easy to install and maintain . . . economical to operate. All tube filament voltages of RCA BTA-5G and 10G transmitters are regulated by Sola Constant Voltage Transformers for longer tube life.**



REAR-VIEW OF POWER AMPLIFIER. **This is the lower se showing three Sola Constant Voltage Transformers installe a BTA-10G unit. Sola regulators are relatively compact c pared to other equipment for comparable ac voltage regula**

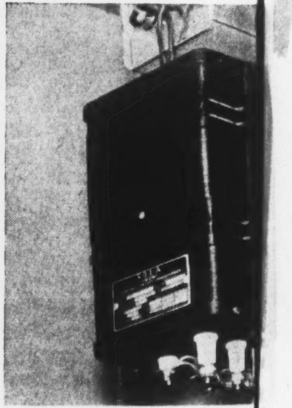
RCA INCREASES TUBE LIFE BY REGULATING FILAMENT VOLTAGE

RCA transmitters are built for 1) *operating ease*, 2) economy and 3) *reliability*. Sola Constant Voltage Transformers are used by RCA in their AM Broadcast Transmitters Types BTA-5G and 10G to help provide these three important advantages.

Sola Constant Voltage Transformers are static-magnetic regulators. In this particular application, they were used as the source of regulated voltage for all tube filaments. They provide secondary voltages regulated within ±3% regardless of primary voltage (transient or continuous) variations as great as 30%.

1. ***They provide operating ease because:*** **regulation is completely automatic, continuous . . . no manual adjustments required . . . no moving or renewable parts.**
2. ***They provide economy because:*** **conventional unregulated power transformer and voltage regulating circuit are eliminated . . . tubes last longer with regulated filament voltage.**
3. ***They provide reliability because:*** **regulating response time is 1.5 cycles or less . . . self protecting against short circuits on output and load circuits . . . current-limiting characteristic protects load equipment against faulty currents.**

That's how Sola Constant Voltage Transformers helped maintain RCA's high performance standards. They can solve your voltage regulation problems too. When your equipment is protected by a Sola built-in stabilizer you know that you automatically have provided the proper operating voltage level regardless of line voltage conditions.



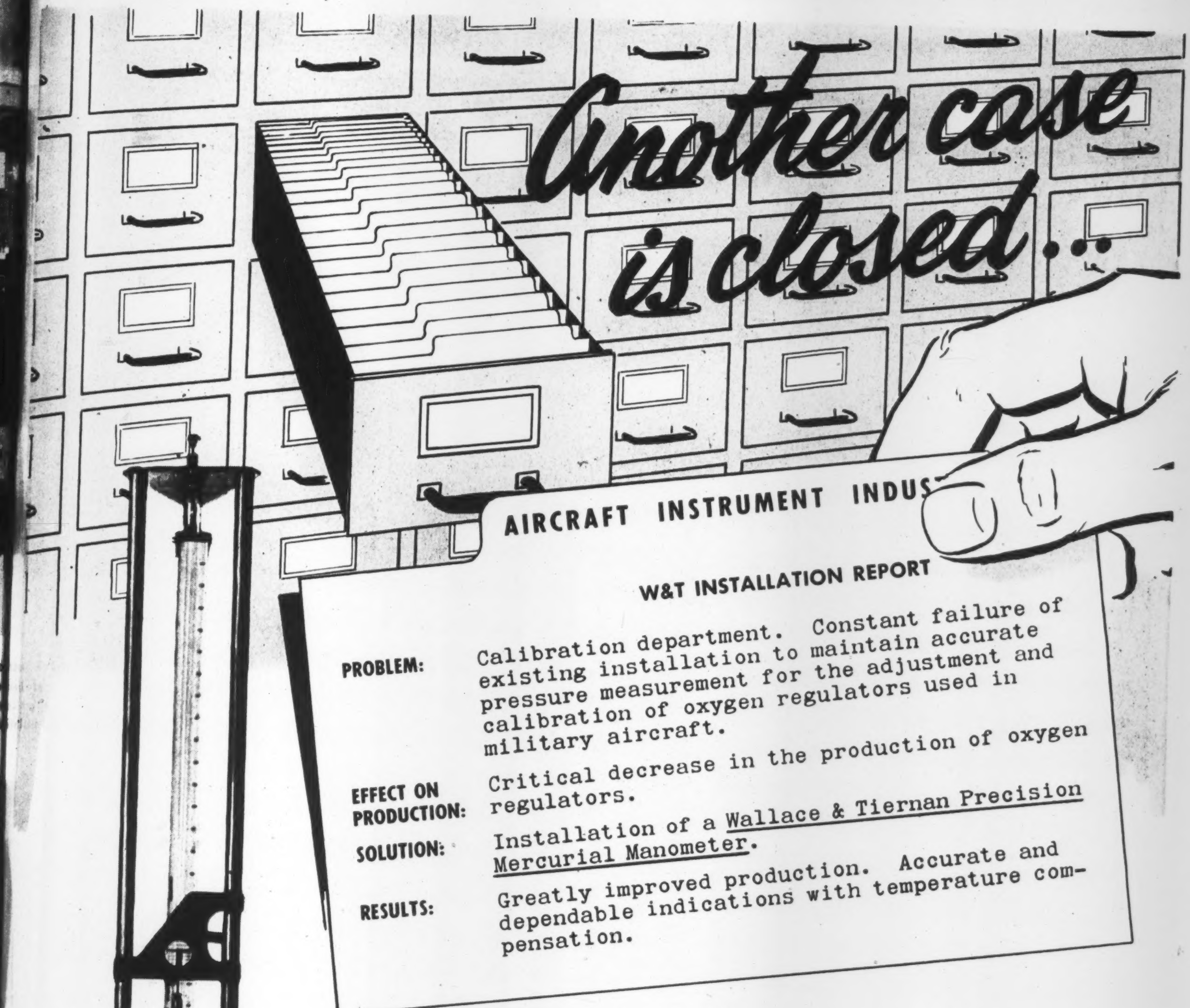
STATIC-MAGNETIC REGULATIO **Standard Sola stabilizers ar available in capacities from 15w to 10kva, and with a variety o common power line and filame voltages. Special designs can b produced for quantity orders.**

Send for the twenty-four page catalog which gives electrical and mechanical specifications for Sola Constant Voltage Transformers. Write on your letterhead for Bulletin GCV-142.

Applications unlimited for

SOLA *Constant Voltage* **TRANSFORMER**

Transformers for: Constant Voltage • Fluorescent Lighting • Cold Cathode Lighting • Mercury Vapor Lighting • Luminous Tube Signs
Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • **SOLA ELECTRIC CO., 4633 W. 16th Street, Chicago 50, Illinois**
New York: 103 E. 125th St., New York 35, N.Y., TRafalgar 6-6464 • Cleveland: 1010 Euclid Ave., Cleveland 15, O., PRospect 1-4005
Boston: 246 Walnut St., Newtonville, Mass. DEcatur 2-3510 • Philadelphia: Commercial Trust Bldg., RIttenhouse 6-4988 • Reps. in Principal Cities


Another case is closed...

AIRCRAFT INSTRUMENT INDUS

W&T INSTALLATION REPORT

PROBLEM: Calibration department. Constant failure of existing installation to maintain accurate pressure measurement for the adjustment and calibration of oxygen regulators used in military aircraft.

EFFECT ON PRODUCTION: Critical decrease in the production of oxygen regulators.

SOLUTION: Installation of a Wallace & Tiernan Precision Mercurial Manometer.

RESULTS: Greatly improved production. Accurate and dependable indications with temperature compensation.

W&T
PRECISION
MERCURIAL
MANOMETER

...Thanks to a W&T Precision Instrument

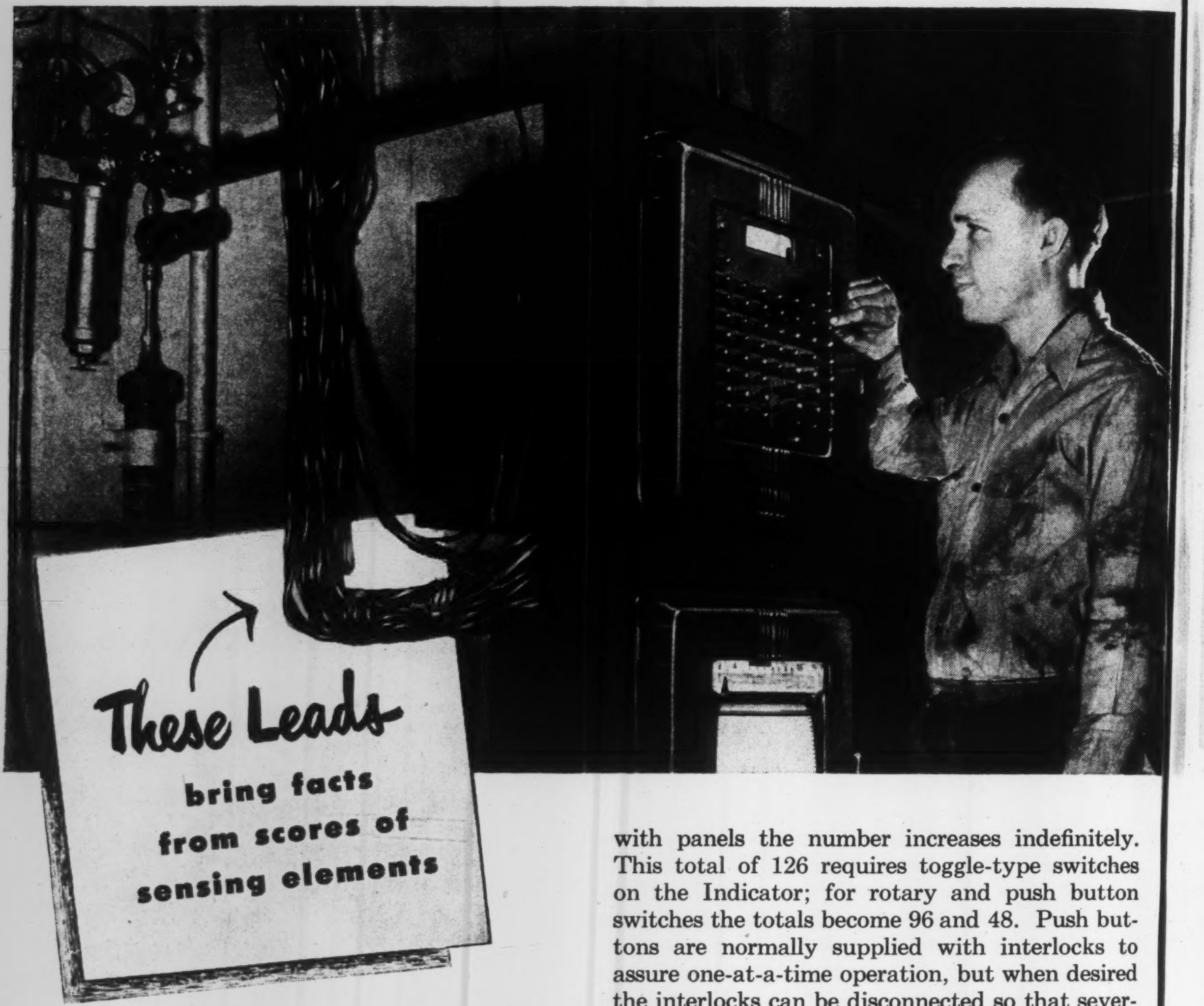
FEATURES:

- **Scales are made with a precision dividing machine**
- **Precision bore tubing provides accuracy with interchangeability**
- **Float type indicator eliminates difficulty in reading meniscus**
- **Mercury-sealed valve permits evacuating the tube easily and quickly**

If you have a problem in the measurement or control of pressure, write today for additional information.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey • Represented in Principal Cities
In Canada, Wallace & Tiernan Products, Ltd. — Toronto

A-92



Engineers and process operators can save themselves a lot of time and energy in running tests when they use Speedomax Electronic Indicators for "round-up" checks of temperature and other process conditions.

A flick of the finger connects the desired sensing element to the Indicator . . . the instrument's calibrated drum whirls to the reading . . . the drum stops dead still. The entire operation takes only 4½ seconds for consecutive readings at opposite ends of the scale. Minimum time for close-together points is only a fraction of a second. Logging time depends only on the writing speed of the operator.

126 COUPLES ON ONE INDICATOR

As many as 126 thermocouples may be connected to one Indicator without the use of side panels; with panels the number increases indefinitely. This total of 126 requires toggle-type switches on the Indicator; for rotary and push button switches the totals become 96 and 48. Push buttons are normally supplied with interlocks to assure one-at-a-time operation, but when desired the interlocks can be disconnected so that several switches may be closed simultaneously, causing the instrument to give the average of those points.

As many as 96 Thermohm electrical resistance thermometers may be connected to the Indicator, using either toggle or rotary switches.

Because the Indicator's scale is not a disc, but the rim or "tread" of a drum-like wheel, the calibration lines are non-radial and hence unusually easy to read. The drum's 25-inch scale has an average of 300 divisions . . . can have 500 if necessary. Enclosed slidewire, and thorough shielding against stray fields, are typical details of high-quality construction.

The equipment is described in our Catalog ND46(1). Whether or not you require this information at present, we will be glad to send a copy for reference. Address our nearest office, or 4955 Stenton Ave., Philadelphia 44, Pa.

LEEDS & NORTHRUP CO.
instruments • automatic controls • furnaces

Jrl. Ad ND46-420(1a)

SIZES AND SAVINGS TO SUIT YOU...

in Stainless Steel Bellows Assemblies

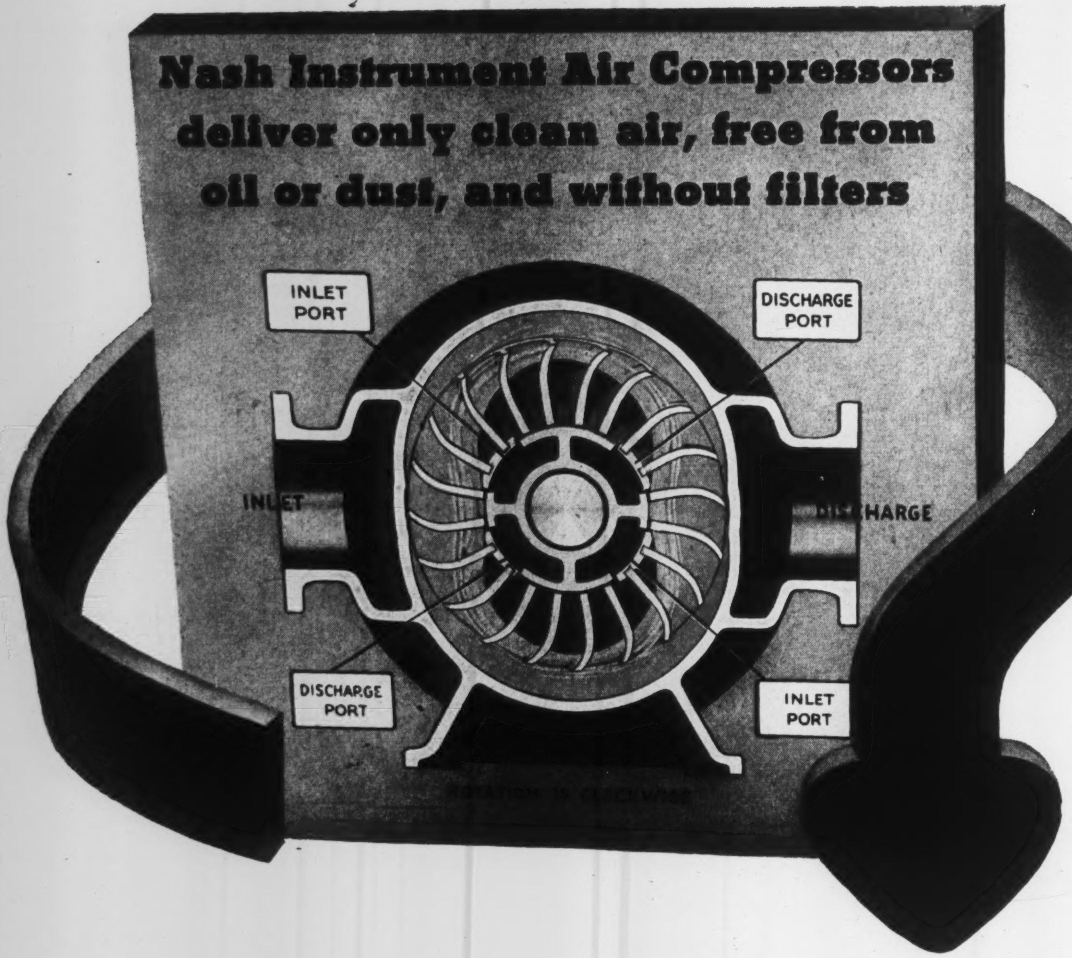
You can count on getting exactly the kind of stainless steel bellows assemblies you require—at a savings—from Fulton Sylphon or Bridgeport Thermostat. For we design and engineer them to your specifications—to do specific jobs. For example—for thermostatic devices . . . flexible connectors . . . expansion joints . . . pressure controls . . . hydraulic mechanisms and other uses.

And, your savings begin the moment you let us take over the job for you. Our half-a-century of experience in this specialized field can help solve knotty problems for you quickly and efficiently. Our skilled personnel and ample facilities can relieve you of all production problems and worries. Find out how you can cut your production costs—with our help on your stainless steel (or other metal) bellows assemblies requirements. Write for complete information. Ask for idea-packed Catalog VE- 1200.

FULTON SYLPHON
DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton
CONTROLS COMPANY
EVERYTHING'S UNDER CONTROL
TEMPERATURE CONTROLS • BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.


Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters
INLET PORT
DISCHARGE PORT
INLET
DISCHARGE
DISCHARGE PORT
INLET PORT
ROTATION IS CLOCKWISE

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

FROM 150 VA

TO 100 KVA

POWERSTAT

Variable Transformers

PROVIDE A CONTINUOUSLY-ADJUSTABLE SOURCE OF A-C VOLTAGE

EFFICIENTLY
ACCURATELY
DEPENDABLY

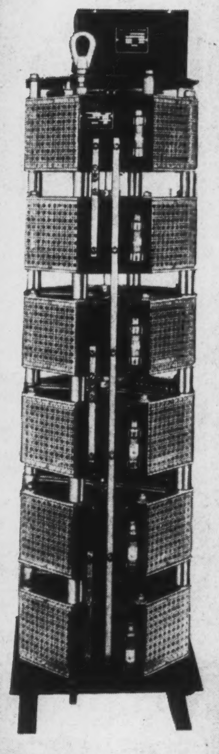
Today's requirements for variable a-c voltage control are numerous. Variable transformers are needed for applications involving loads as low as 100 watts and as high as 100 KVA. Only POWERSTAT variable transformers are provided in a range of models to fulfill the demands of individual needs. Standard types are available for manual or motor-driven operation in ratings of 115, 230 and 460 volts; 25, 50/60 and 400/800 cycles; single and three phase; 0.15 to 100 KVA. Oil-cooled and Explosion-proof POWERSTATS are offered for use in corrosive and hazardous atmospheres.

All POWERSTATS feature excellent regulation, high efficiency, conservative ratings, zero waveform distortion and accurate adjustment to fractions of a volt. Mechanical construction is rugged and provision has been made for easy bench, wall or back-of-panel mounting.

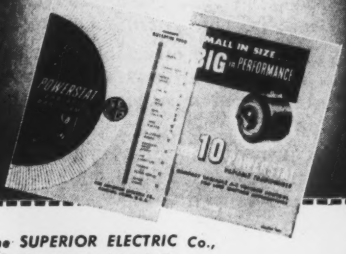
Whatever your variable a-c voltage needs, there is a POWERSTAT variable transformer to do the job — and do it better.

SEND NOW FOR COMPLETE INFORMATION

TYPE 10
INPUT: 120 VOLTS, 60 CYCLES, 1 PHASE
OUTPUT: 0-120/132 VOLTS, 1.25 AMPERES
150/165 VA



TYPE MW1156L-6Y
INPUT: 230 VOLTS, 50/60 CYCLES, 3 PHASE
OUTPUT: 0-230 VOLTS, 90 AMPERES, 35.8 KVA



THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

- STABILINE AUTOMATIC VOLTAGE REGULATORS
- POWERSTAT VARIABLE TRANSFORMERS
- VARICELL D-C POWER SUPPLIES
- VOLTBOX A-C POWER SUPPLIES
- SUPERIOR 5-WAY BINDING POSTS
- POWERSTAT LIGHT DIMMING EQUIPMENT

The SUPERIOR ELECTRIC Co.,
711 Thure Ave., Bristol, Conn.

Please send free copies of the POWERSTAT bulletins P550 and P252.

NAME ____________________

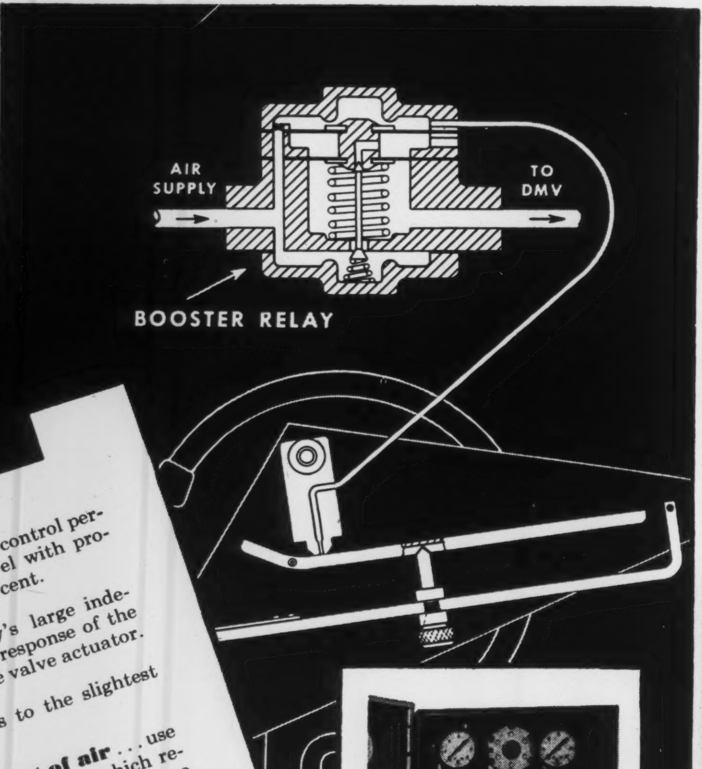
POSITION ____________________

CO. NAME ____________________

CO. ADDRESS ____________________

CITY __________ ZONE ___ STATE ___

It's the **BOOSTER RELAY** that gives this Pressure Controller these **4** exclusive features



1. **It's accurate** . . . provides closest control performance, including full valve travel with proportional band set as low as 1 per cent.
2. **It's fast** . . . the booster relay's large independent air supply permits fast response of the valve, regardless of the size of the valve actuator.
3. **It's sensitive** . . . responds to the slightest pressure changes.
4. **It uses a minimum amount of air** . . . use of booster relay permits small nozzle which requires only 0.1 scfm under steady state pressure conditions.

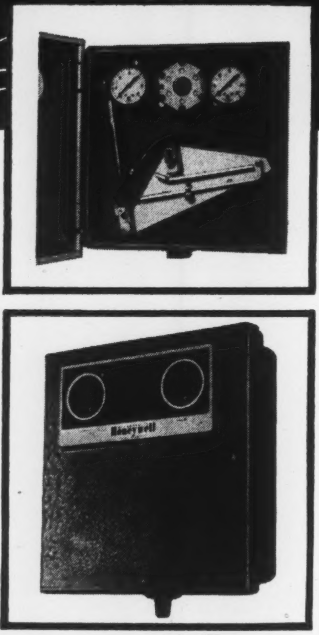
New Honeywell Pressure Pilot ▶

In ruggedness, too, the Pressure Pilot leads the way. It goes anywhere . . . takes the toughest field conditions in stride. It makes a fitting companion, of course, for Honeywell's Series 700 valve line.

It has every other feature you need: easy adjustment of set point, positive overload protection, simple construction, quick reversibility, universal mounting; and best of all, the cost is surprisingly low.

Our nearest engineering representative will be glad to demonstrate the Pressure Pilot for you right in your plant. Call him today . . . he is as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, 1908 Windrim Ave., Philadelphia 44, Pa.



Internal view at top shows arrangement of elements depicted in diagram. External view at bottom shows Pressure Pilot with door closed.

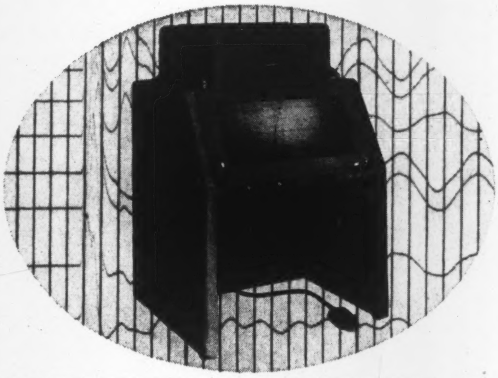
MINNEAPOLIS
Honeywell
VALVE PRODUCTS
First in Controls

H
HONEYWELL

● *Important Reference Data*
Write for new Bulletin 16-1, "Honeywell Pressure Pilot."

Speed up your data analysis

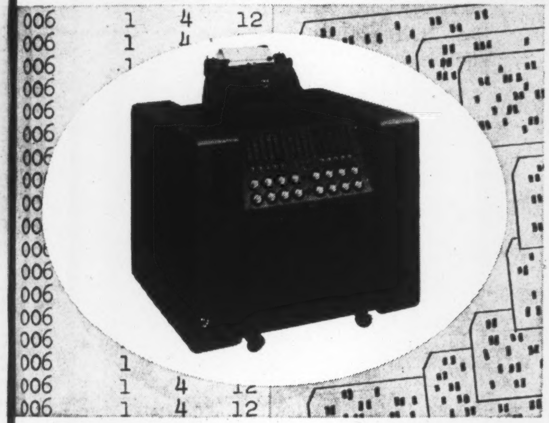
These Telecomputing Instruments measure, record, plot at automatic speeds:



Today you can reduce and analyze film and oscillograph data faster than ever before. Telecomputing Instruments, in conjunction with electronic computing equipment, have made this possible.

The following sequence of automatic data analysis is typical:

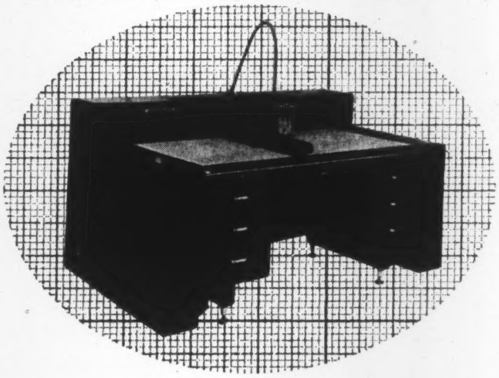
The Universal Telereader measures records ranging from 16 and 35 mm film to 12" oscillograph records. Speed: up to 50 measurements per minute.



The Telecordex records the Telereader measurements in decimal form electronically on its own electric typewriter, transmits the data to an IBM Summary Punch for card punching.

The IBM card punch receives the data from the Telecordex, punches it and continues the cycle.

All necessary calculations, including linear and non-linear calibrations, are performed on IBM or other electronic computers.



The Teleplotter plots the data electronically from IBM cards or a manual keyboard. Speed: up to 70 points per minute.

Technical bulletins on the Universal Telereader, Telecordex and Teleplotter will be mailed you upon your request. Coupon below is for your convenience.

TELECOMPUTING
Corporation
Burbank, California

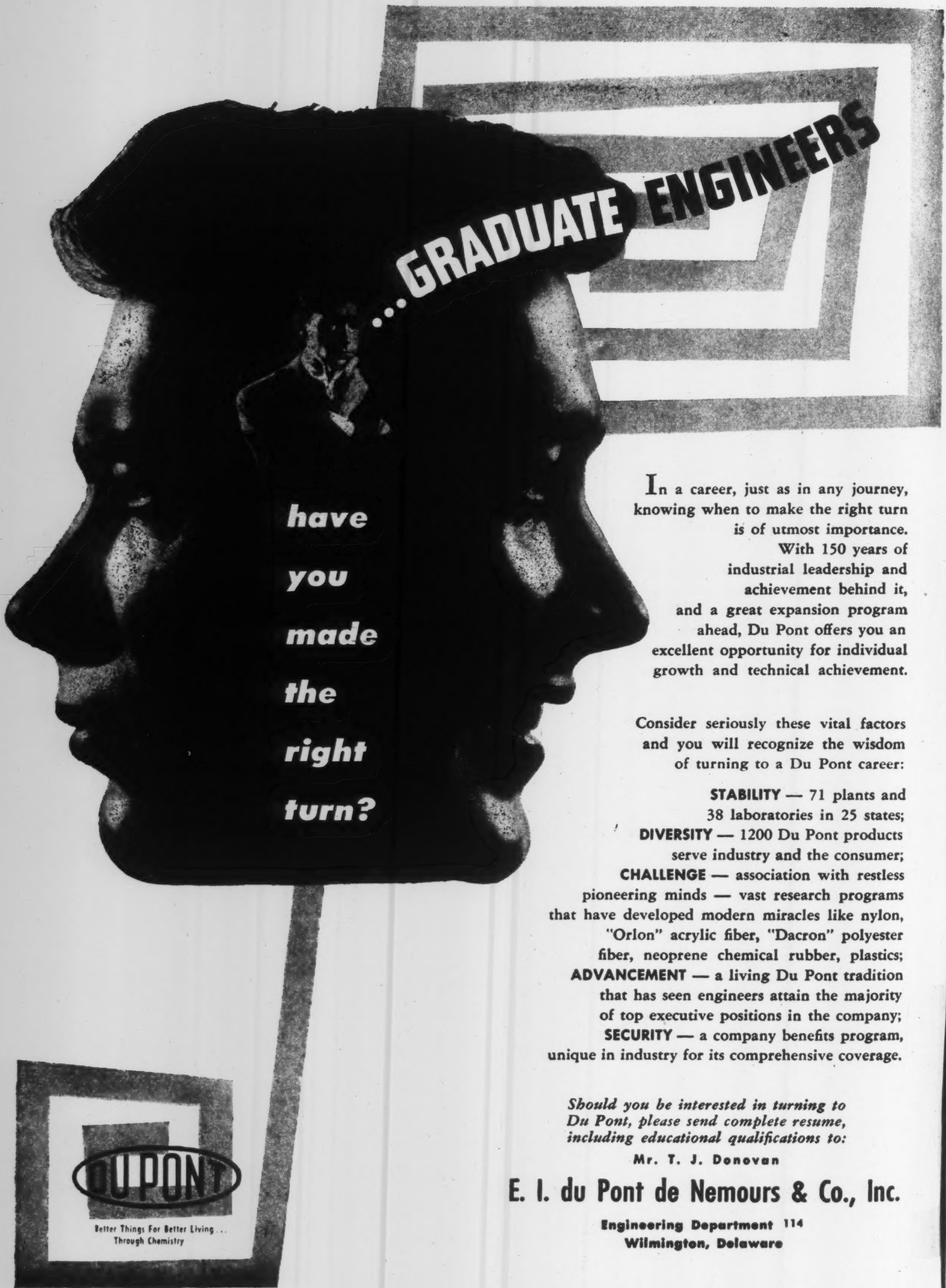
Mr. Preston W. Simms, Engineering, Dept. I-11
Telecomputing Corporation, Burbank, California
Dear Sir: Please send me:
☐ Universal Telereader Technical Bulletin TC 101
☐ Telecordex Technical Bulletin TC 102
☐ Teleplotter Technical Bulletin TC 103

Name ____________________

Company ____________________

Street Address ____________________

City and State ____________________


...GRADUATE ENGINEERS
have you made the right turn?
DU PONT
Better Things For Better Living ... Through Chemistry

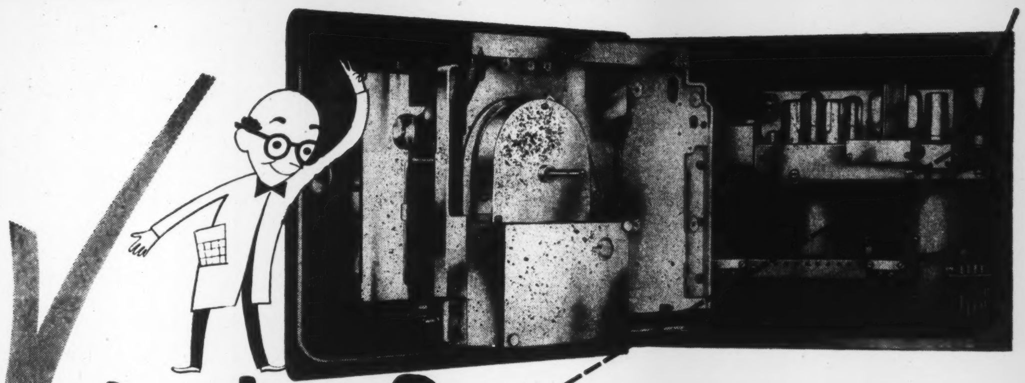
In a career, just as in any journey, knowing when to make the right turn is of utmost importance. With 150 years of industrial leadership and achievement behind it, and a great expansion program ahead, Du Pont offers you an excellent opportunity for individual growth and technical achievement.

Consider seriously these vital factors and you will recognize the wisdom of turning to a Du Pont career:

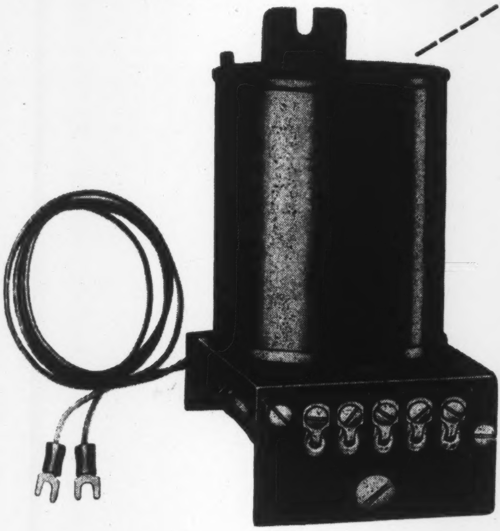
STABILITY — 71 plants and 38 laboratories in 25 states;
DIVERSITY — 1200 Du Pont products serve industry and the consumer;
CHALLENGE — association with restless pioneering minds — vast research programs that have developed modern miracles like nylon, "Orlon" acrylic fiber, "Dacron" polyester fiber, neoprene chemical rubber, plastics;
ADVANCEMENT — a living Du Pont tradition that has seen engineers attain the majority of top executive positions in the company;
SECURITY — a company benefits program, unique in industry for its comprehensive coverage.

Should you be interested in turning to Du Pont, please send complete resume, including educational qualifications to:

Mr. T. J. Donovan
E. I. du Pont de Nemours & Co., Inc.
Engineering Department 114
Wilmington, Delaware



Check the Components



of the BRISTOL DYNAMASTER

Continuous-Balancing Electronic Recorder

The Dynamaster is a superior recording and controlling instrument because every component part is superior.

Take the Syncroverter* Switch; pictured above.

This vibrator-type d-c to a-c converter incorporates so many unique improvements that many scientists, laboratories, and manufacturers are using it in their own devices.

Among its advantages are:

- ✓ Extremely long life
- ✓ Hermetically sealed against dust and corrosion.
- ✓ Dual reeds automatically cancel out thermal-induced emf
- ✓ Shock-proof and vibration-proof
- ✓ 1000-to-1 discrimination against external stray currents
- ✓ Has switching symmetry of better than ½ of 1 percent.

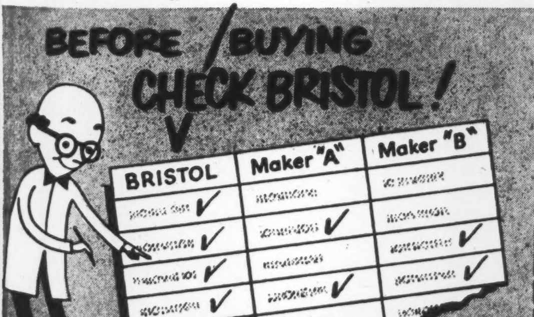
BRISTOL

The Syncroverter Switch is only ONE of the important features of the Dynamaster electronic recorder For full information, send for Catalog No. P1245.

The dependable Guidepost of Industry

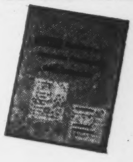
*Reg. U. S. Pat. Off.

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



THE BRISTOL COMPANY
113 Bristol Road
Waterbury 20, Conn.

Please send catalog giving details of Dynamaster performance to:



NAME__________________ TITLE____________
COMPANY____________________________
ADDRESS____________________________
CITY__________________ ZONE______ STATE________

New POTTER *Industrial* FLOWMETER

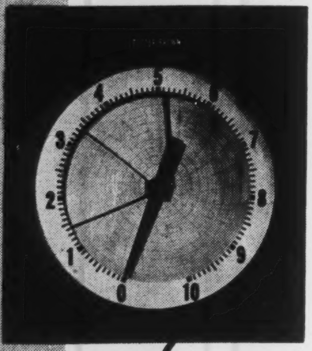
Accurately measures fluids and gases—*Even under difficult conditions*

The new Potter-Brown Electronic Flowmeter is an industrial instrument with the high accuracy and dependability required for laboratory work. The unit handles toxic and highly corrosive materials at pressures up to 20,000 psi and temperatures from 4° absolute to 1,200°F. Installation directly in the flow line is simple and inexpensive. An unusual design feature eliminates bearing maintenance, friction drag, and high pressure drop.

The Potter-Brown Flowmeter comprises a flow-sensing unit having a hydraulically balanced rotor and magnet rotating within a compact non-magnetic housing fitted with an external pickup coil, and means for measuring, controlling, and indicating the flow at one or more locations.

Features

- ***Accurate within ±½%***
- ***Low pressure drop***
- ***No thrust bearing***
- ***Simple installation***
- ***Linear characteristics***
- ***Integral calibration***
- ***Specific gravity compensation adjustment***



ACCURATE within ±½%

The Potter design causes fluid flow through the unit to establish upstream thrust components which exceed the downstream drag on the rotor. This enables the rotor to spin freely without friction in a "no-slip" condition within its rated capacities. Accuracy is maintained within ±½%. Fluid viscosity, pressure, temperature, and specific gravity only slightly affect the volumetric flow rate.

SPECIFICATIONS

Sensing Element Size	Contg. Tube, Size	Over-all Length	Hex.	Height (incl. coil)	Weight in Stainless Steel	Weight in Aluminum	Range, gpm
3/16"	3/8"	2 7/16"	13/16"	1¾"	5 oz.	2½ oz.	.09-.7
3/8"	3/8"	2 7/16"	13/16"	1¾"	5 oz.	2½ oz.	.2-2.0
½"	½"	2 7/16"	13/16"	1¾"	5 oz.	2½ oz.	.9-9
5/8"	5/8"	2 7/16"	1⅛"	2⅛"	7 oz.	3½ oz.	1-12
¾"	¾"	3¼"	1⅜"	2 5/16"	12 oz.	5 oz.	1½-20
1"	1"	3½"	1⅝"	2 9/16"	22 oz.	10 oz.	2-40
1¼"	1¼"	3⅞"	1⅞"	2 13/16"	28 oz.	13 oz.	3½-90
1½"	1½"	4⅜"	2⅛"	3 1/16"	37 oz.	16 oz.	6-125
2"	2"	4¾"	2¾"	3 11/16"	48 oz.	20 oz.	10-250

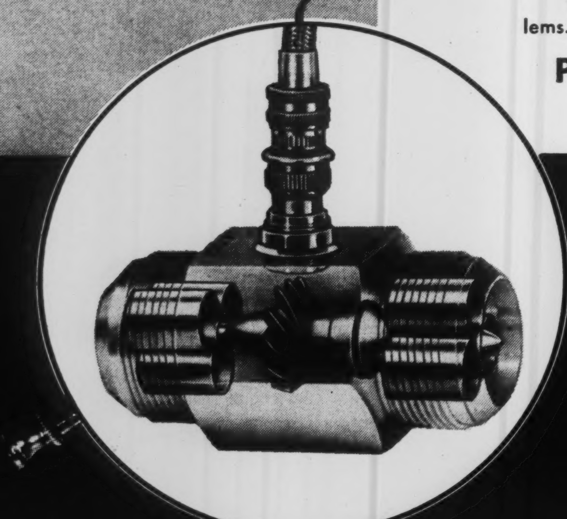
Operation

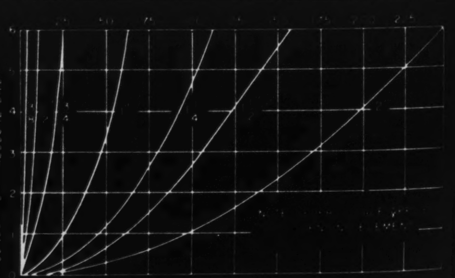
Electric impulses generated by the magnet within the sensing element rotor are transmitted by the pickup coil to a converter which delivers dc voltage output proportional to the ac frequency of the sensing element. A potentiometer measures and records the dc output as flow.

For measuring fluids of varying specific gravities and for recording, indicating, and totalizing flow in weight units, a unit with specific gravity adjustment is available, which allows accurate setting of the instrument to compensate for density variations.

We will gladly help you solve your flow measuring problems. Send for new bulletin.

POTTER AERONAUTICAL COMPANY
87 Academy Street, Newark 2, N. J.



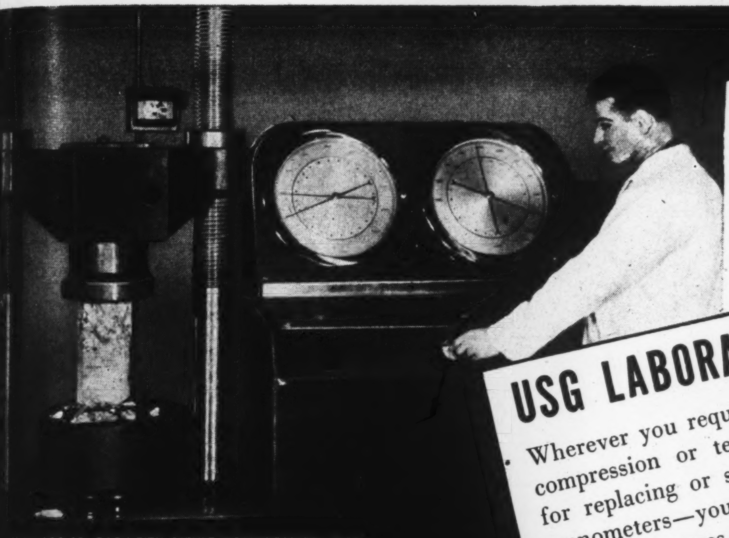


High venturi efficiency of patented sensing element design results in very low pressure drop

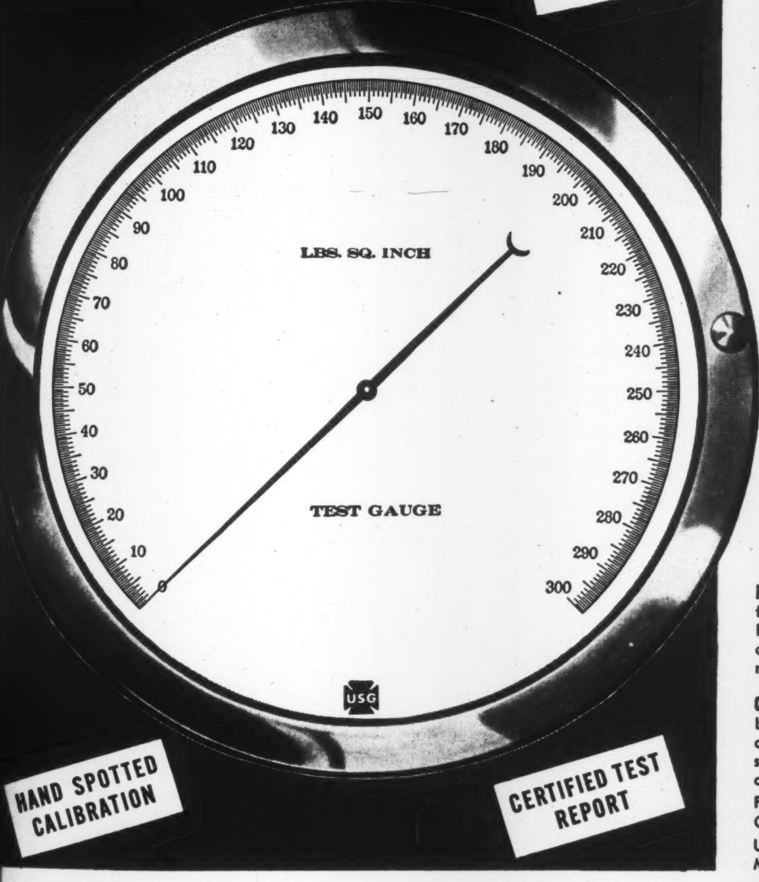
For Peak Precision

USG LABORATORY TEST GAUGES

Wherever you require *peak precision* from a gauge—for compression or tensile strength testing machines, or for replacing or supplementing dead weight testers or manometers—you can use the accuracy of USG Laboratory Test gauges to advantage.



"300,000 LB. CAPACITY RIEHLE COMPRESSION TESTING MACHINE, MADE BY RIEHLE TESTING MACHINE DIVISION OF AMERICAN MACHINE AND METALS, INC."



HAND SPOTTED CALIBRATION

CERTIFIED TEST REPORT

PEAK PRECISION—½ of 1% of the indicated reading above 20% of the maximum dial range and one part in 500 (0.2%) below 20% of the maximum dial range. A Certified Test Report is furnished without charge for applying corrections when instrument is used at accuracies higher than ½ of 1% of indicated reading.

PRECISION DRAWN TUBE—Drawn from phosphor bronze, beryllium copper, or 403 stainless steel—depending on pressure range. All tubes are specially treated to produce minimum hysteresis and drift.

PRECISION MOVEMENT—Aircraft quality for highest sensitivity. Nickel-dipped bronze with extra long bearings and heavy bronze bushing fitted with nickel silver pinions and arbors.

PRECISION CALIBRATION—Graduations are individually hand-spotted and engraved on a white background. Dial may be rotated 10° for zero adjustment to compensate for preloading.

DIAL SIZES—12" and 16".

PRESSURE RANGES—All pressure ranges from 30" Vacuum and 15 to 20,000 p.s.i. Ranges over 30,000 p.s.i. on special order. Suppressed scales available on request.

CASE AND RING—Cast aluminum case, black finish. Cast brass ring with polished chromium finish. Flush panel mounting or surface mounting with back or lower connection.

For additional information, write for USG Catalog 64.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

Quality Gauges Engineered for Enduring Accuracy UNITED STATES GAUGE

ODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges
emical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges
Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC. AT SELLERSVILLE, PA.: GOTHAM INSTRUMENTS, AND AUTOBAR SYSTEMS.

It "Takes the Pick" of Your Clothes

4000
3000
2000
1000
1 2 3 4
MON
TUES
WED
THURS
FRI
SAT
VR50
VEEDER-ROOT

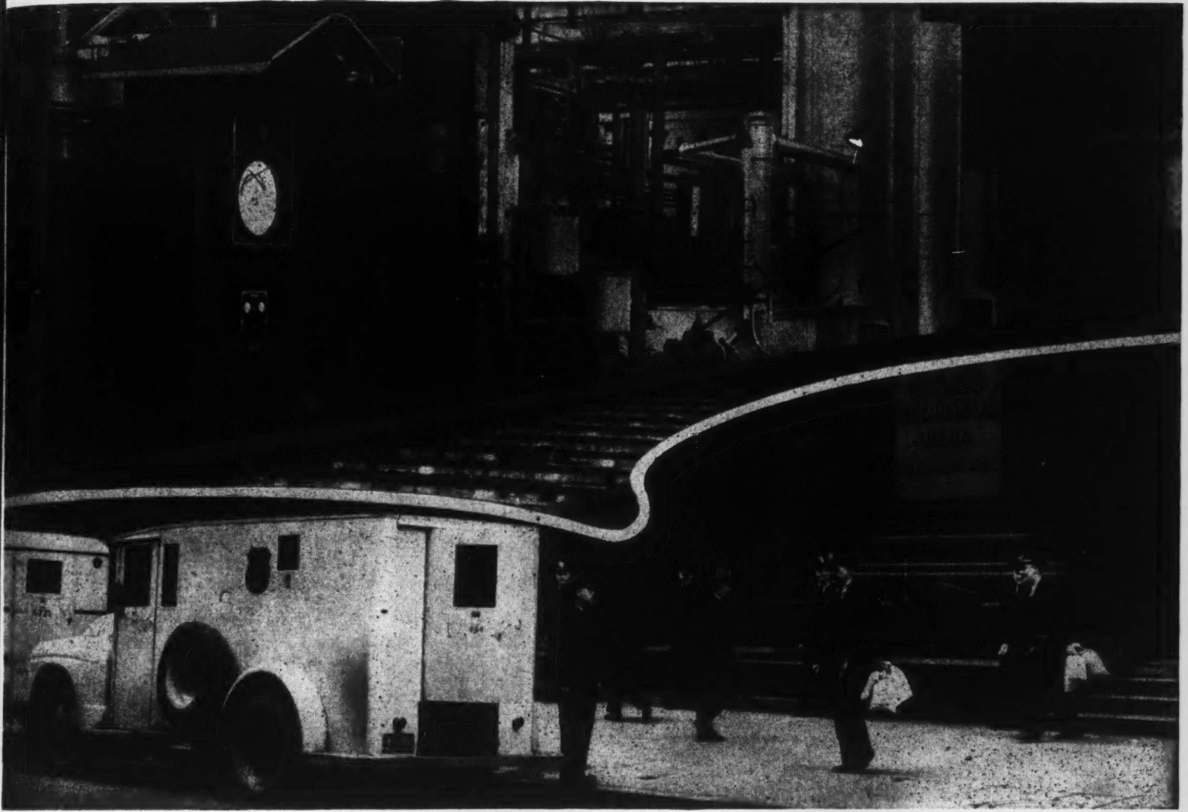
Added Evidence that

Everyone Can Count on VEEDER-ROOT

Weavers know this as a Pick Counter, because it counts the picks, or trips of the shuttle across the loom as cloth is woven. And this is the newly modernized model of the original V-R 2-3 Convertible Counter. 4th counting unit is also available.

This is another V-R "first" in advancement of counter design for every field of industry. And it's more than likely that V-R can supply or design a counter that will count to *your* advantage. Find out. Write:

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N.Y. • Greenville, S.C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities



Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

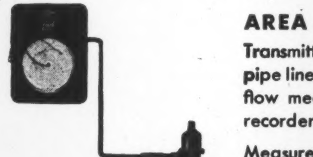
TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials.

P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 96,000 lb. per hour.

BAILEY METER COMPANY

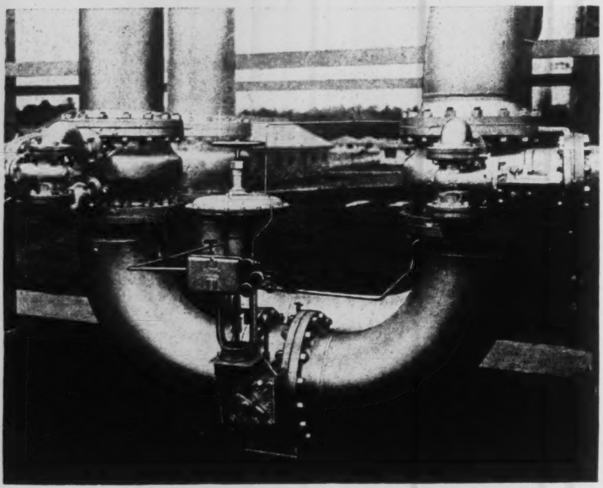
1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



R-S Automatic Valve installed on water jacket to gas engine in gas booster station.

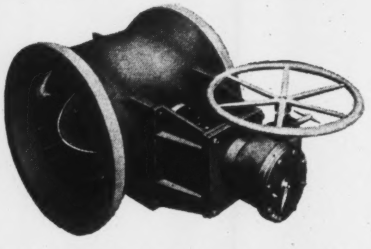
WIDE RANGE of Application

R-S Valves are used in air, gas, liquid, steam, and semi-solid service for the shut-off and regulation of volume and pressure, pressure relief, liquid level control, back pressure, water hammer, steam hammer, constant differential pressure, and the output control of pumps, fans, engines and turbines. Suitable for service in the temperature range from minus 300° to plus 2000° F. 2 to 2500 psig.

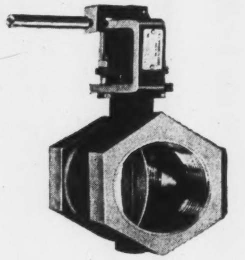
Simplicity of design, ease of operation, positive rubber seat shut-off, and the wide range of application indicate the high order of metallurgical and mechanical engineering that is embodied in every R-S valve.

Consult your local R-S Valve Engineers, or write direct.

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary
DISTRICT OFFICES IN PRINCIPAL CITIES

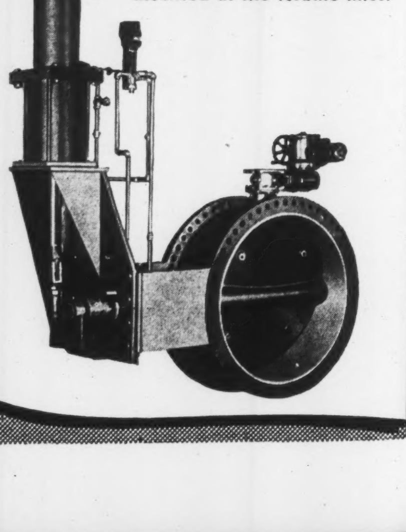


No. 836—24-inch 125-pound cast iron hub-end valve with bronze liner and monel periphery on vane for water service. Equipped with totally enclosed gear reducer, handwheel and locking device.



No. 801—3-inch 125-pound bronze screwed-end valve with handlever control and locking device.

No. 828—60-inch 150-pound cast steel valve with 18-8 shafts, bronze bushings and bronze body liner. Cylinder operator is controlled by electric motor operated 4-way valve. Handwheel control for manual operation. Equipped with outboard bearing on mounting bracket and a 6-inch 125-pound cast iron motor operated by-pass valve on top of 60-inch valve. Valve used for turbine shut-off and is mounted at the turbine inlet.



OHMITE®
ELECTRICAL CONTROLS

RESISTORS
TAP SWITCHES
RHEOSTATS
OHMITE TAP SWITCH
CHICAGO

...GIVE EXTRA DEPENDABILITY

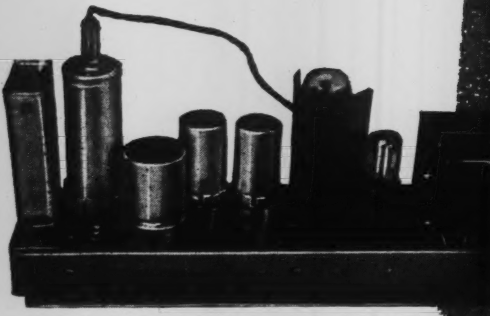
The reputation of your product rests upon the reliability of every part that goes into its construction. Ohmite electrical controls . . . rheostats, resistors, and tap switches . . . have been engineered for long life . . . built to give years of trouble-free service without maintenance. That's why more manufacturers have standardized on Ohmite wire-wound resistance units for controlling electrical currents and voltages, than any other rheostat or resistor on the market.

Ohmite Manufacturing Co., 4887 Flournoy St., Chicago 44, Illinois.

Write on
Company Letterhead for
Catalog and Engineering
Manual No. 40

OHMITE

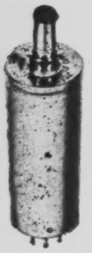
First in WIRE-WOUND RHEOSTATS and RESISTORS



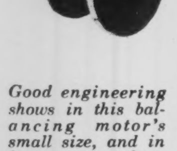
A lot of Engineering for an Amplifier, but...

Good engineering shows in this Amplifier's wide range of sensitivities, and of impedances, thorough filtering and plug-in connection to the rest of the Speedomax instrument.

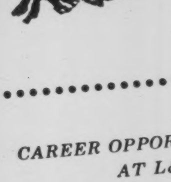
it helps Speedomax to fit your ideas!



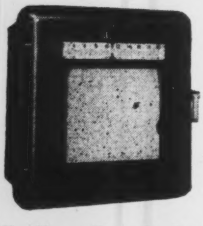
Good engineering shows in this Converter's phenomenally low noise level and in its long-lived performance.



Good engineering shows in this Slidewire's non-inductive winding and in absence of any flexible leads which might form inductive loops.



Good engineering shows in this balancing motor's small size, and in its torque ample to operate accessory control and signalling fitments.



• Your needs and ideas put this electronic "tool" to work on an amazing variety of jobs. Controlling furnaces and peering into atoms; counting bottles and spying on the weather; taking the "shine" out of rayon or putting it on hardware, to name six out of thousands of uses. For, in general, if you can feed Speedomax a tiny electrical signal, representing the condition you wish to measure, the instrument will not only put "calipers" on it, but will amplify it enormously to direct anything that can be directed through electrical or pneumatic means.

The Speedomax way of handling this job provides particularly accurate results and an especially good fit in meeting your individual ideas. For instance, there's the matter of receiving the signal in a way suited to its size—or, more usually, to its smallness.

We have no less than twenty-three carefully-engineered Speedomax Amplifiers covering a wide range of sensitivity and impedance levels. One Amplifier in the series enables the Speedomax to respond to a signal of only 10^{-16} watt—one ten-billionth of a microwatt. No other recorder amplifier comes within 3 magnitudes of this figure. Such sensitivity means corresponding accuracy in detecting the tiny unbalance—called "error" by circuit engineers—which actuates the rebalance system.

In terms of power, all 23 Amplifiers deliver the same—5 or 6 watts. This is from 2 to 4 times the output of other recorder amplifiers; permits a more powerful balancing motor. And the Amplifier-Motor team provides an especially high torque gradient just where it's needed—centering around the balance point—for prompt, positive balancing and easy, effortless operation of a "heavy" load of control or signal devices in the motor shaft.

The Speedomax story for industry is told in Catalog ND46(1); for Research, in Tech. Pub. ND46(1). We will send either on request; address our nearest office or 4955 Stenton Ave., Phila. 44, Pa.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

LEEDS NORTHRUP

instruments automatic controls • furnaces

Jrl. Ad. ND46(7)

From the Publisher of *Instruments*

Dear Subscriber:

Three matters call for my addressing a few personal words to you:

1. An Invitation.—The January issue of *Instruments* will be its 25th Anniversary Issue in which, as usual on such an occasion, the past and the future will be examined. Therefore, I earnestly invite all thoughtful and experienced readers to contribute brief statements—each on the prospects for his own field. We here in Pittsburgh cannot possibly know the specific plans—far less the ideas and aspirations—of thousands of imaginative "Instrument Men." YOU, for example, have some constructive ideas that are not known outside of your intimate circle. This is your opportunity to air these ideas which may contribute to the future progress of America through Instrumentation.

(Note. Brevity is essential: 200 words should suffice. Manuscripts should be typed double-space on one side of paper. And PLEASE have your contribution reach us by Monday December 15.)

2. Instrument & Apparatus News—.This is the name of a new tabloid-style bimonthly magazine, whose first issue will appear in February 1953. It will be sent every two months to 100,000 technical workers who are not subscribers to *Instruments*. To them it will bring news of new instruments and new literature, all picked up from previous issues of *Instruments*. It will have no technical articles. Naturally, it will not be sent to *Instruments* subscribers—who will have read all the news items in *Instruments*.

I&AN will perform a much-needed job of "public information."

3. Only a Rumor!—C. F. Goldcamp, our Sales Manager, recently called on a large Central New York State company which advertises in *Instruments*. He was told by one of that company's advertising men that a rumor was being circulated by the sales representative of another publisher.

The rumor: "*Instruments* Magazine is being bought by the Instrument Society of America."

The fact: Never in its twenty-five years of service has *Instruments* been offered for sale and there is no ground for the assumption that such an offer will be made.

The *Journal* of the Instrument Society of America is included in every issue of *Instruments*. Other than this simple arrangement, there is no connection whatever between the Instrument Society of America and The Instruments Publishing Company.

Richard Rimbach, President,
The Instruments Publishing Company.

Editorial Comment

Electronics?

W. L. Everitt, prominent author, Fellow and Past President of the IRE, and Dean of the College of Engineering of the University of Illinois suggests (in the August 1952 issue of the *Proceedings of the I. R. E.*) the following "re-definition" of electronics:

"Electronics is the science and technology which deals primarily with the supplementing of man's senses and his brain power by devices which collect and process information, transmit it to the point needed, and there either control machines or present the processed information to human beings for their direct use."

We do not like to take exception to the idea of so prominent a man. But this precise definition of INSTRUMENTATION must not be permitted to be abused in this manner. There happen to be many NONELECTRONIC pneumatic, hydraulic, optical, chemical, electrical, and mechanical instruments which "supplement man's senses and power by collecting information, transmitting it where needed, and there controlling machines." Many of these nonelectronics devices are very old and reliable servants of mankind. Although all these nonelectronic portions of the field of Instrumentation now greet electronic devices as full partners in the continuing struggle against man's sensorial and muscular limitations, they are not yet ready to be called "electronic."

On Technical English

While we are in the mood to take exception with the giants in our field, we shall review the new book "Instrument Engineering," Vol. 1, Methods For Describing The Situations of Instrument Engineering, by Charles S. Draper, Walter McKay, and Sidney Lees of M. I. T. (McGraw-Hill Book Co., 1952, $6.00).

The primary purpose of this book is to represent the static and dynamic responses of open- and closed-loop systems in terms of performance operators and performance functions. Operating systems are generalized and basic concepts and notations are presented. Statistical methods and sinoidal responses also are included. Emphasis is on notational conventions throughout the book.

The technical job is excellent, the mathematics is profound, and the subject is important. But one serious defect must be pointed out if only because the title of the book is "Methods For Describing the Situations of Instrument Engineering." Someone must object when terms such as "actuating input function product—reference input function product performance function ratio function" (p. 134), "single reference quantity—single dependent quantity performance function form" (p. 234), or "amplitude ratio determined frequency ratio operating range upper limit" (p. 256) are considered terminology for functions of any type. These are not three isolated examples. Starting on page 17 with "balance mass screw drive motor power control system" and right down to the last sentence in the book—"For this reason, the reference input function product is placed in the compared quantity subscript position, and the identified input function product is given the reference quantity subscript position in the subscripts for the frequency function ratio function"—the book uses a German-brand of English that will not help describe "situations of instrument engineering." The danger is that the subject will appear much more complicated to the student than it really is.

English phrases of this lengthy type are unwieldy, difficult to assimilate, and (worst of all) ambiguous. There is a host of meanings ascribable to the term "balance mass screw drive motor power control system." It could be a balance system for power control of a mass-screw drive, or it could be a balance-control system for mass-screw drive of motor power, or it could be several other things, including the author's intended one—power-control system for the balance-mass-screw-drive motor. Note that this contains every word that the original does, but in unambiguous form. All that the author need have said is "control system for the screw-drive motor."

We make these points to show that poor technical English is ambiguous. For example, in an oscilloscope the deflection plates which deflect the spot horizontally are situated in a vertical position. Thus the horizontal-deflection plates ARE vertical deflection plates; similarly vertical-deflection plates ARE horizontal deflection plates.

The purpose for writing the above is two-fold. First, authors of technical literature should learn the art of writing clearly and simply (or else employ good technical editors). Secondly, we want our readers to know that there is a difference between brands of technical English; we work hard to make it the best for you. **MHA**

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1627

Oxygen Analyzer

New "Model F-3," latest addition to maker's line of oxygen analyzers, is designed for combustion applications in power plants, steel mills, cement and ceramic kilns, and petroleum refineries. It indicates oxygen content of flue or process gas by utilizing fact that oxygen is unique among gases in that it is strongly paramagnetic (attracted into a magnetic field). "F-3" measures magnetic susceptibility of a continuous sample of flue or process gas; therefore is unaffected by gases other than oxygen. Accuracy is within 1 percent of full scale for spans of 5 percent and greater. Combustion ranges include 0-5, 0-10, 0-15 percent, and are supplied with a second range of 25 percent. Other ranges to 0-100 percent are available. A positive check of proper operation is made by recording air-point on second range. Any standard potentiometer recorder, controller, or pneumatic receiver can be used with "F-3."—*Arnold O. Beckman, Inc.*, 1020 *Mission St., South Pasadena, Calif.*

Mention No. 1401 when filling out card.

Manual-loading Stations

New models of maker's loading stations have effective operating range extended to 0-28 psi. Range extension has been made available for regulating single-seated and three-way valves operating against high upstream pressure. —*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia* 44, *Pa.*

Mention No. 1402 when filling out card.

Manual Relay for Optional End-point Process Control

New cut-off relay provides end-point temperature (or pressure, pH, etc.) control for processes requiring automatic shutdowns and manual resetting.

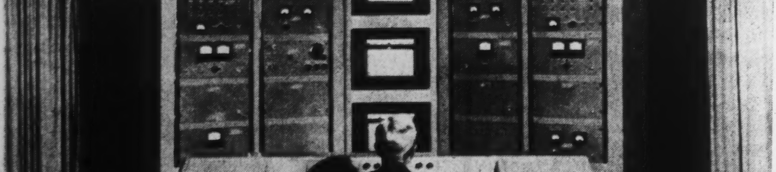
It operates as follows (temperature example): During heating period with "low" contact of temperature controller closed, operator depresses a contact pushbutton in relay. This lights a green signal, and motorized valve is energized to supply heat to process. When process temperature reaches set point and "low" contact opens, valve circuit is broken, de-energizing signal light. Power will not be restored to valve when controller's "low" contact closes unless relay's reset button is depressed. Relay capacity, 13 amps. at 115 v. or 6.5 amps. at 230 v.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia* 44, *Pa.*

Mention No. 1404 when filling out card.

Reactor-control Instrumentation

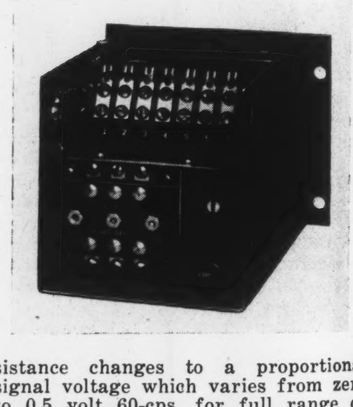
New nuclear reactor control instrumentation, said to be complete, is commercially available. All instruments are made to Oak Ridge National Lab specs. They include: period amplifier, log count rate meter, sigma amplifier, power supply for compensated ionization chamber, magnet amplifier, log n amplifier, Oak Ridge A1 linear amplifier, micromicroammeter, period recorder, log n recorder, parallel circular plate chamber and compensated ionization chamber. Undersigned are also offering their services and counsel. —*Reactor Dept., Radiation Counter Laboratories, Inc.*, 5122 *W. Grove St., Skokie, Illinois.*

Mention No. 1403 when filling out card.



Temperature Transmitter

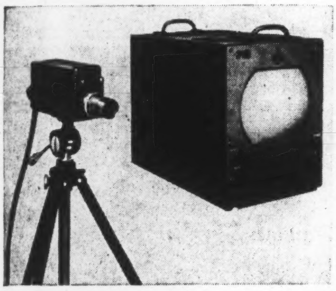
New "Type T2T Autronic Temperature Transmitter," designed primarily for use with maker's "Autronic Control System," comprises two major assemblies: resistance thermometer element and thermometer adapter unit. Thermometer element is made of pure platinum wire wound on a ceramic core and sealed in an Inconel tube. Standard thermowell, lagging extension thermowell, or finned thermowell styles are available. Adapter unit converts resistance changes to a proportional signal voltage which varies from zero to 0.5 volt 60-cps. for full range of measuring element. Three-wire system compensates for variations in lead wire resistance. A special adjustment compensates for minor variations in thermometer element resistance. Each thermometer element is factory calibrated and compensator setting for thermometer adapter is determined and stamped on thermometer name plate. Adapter unit removable range card gives a total of 24 spans, with extreme limits of minus 50 C. and 325 C.; also available in F.; special range cards can be supplied.—*The Swartwout Co.*, 18511 *Euclid Ave., Cleveland* 12, *Ohio.*



Mention No. 1405 when filling out card.

Closed-circuit Industrial Television System

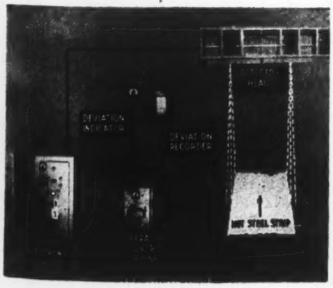
New "Model 1 TV-5" first commercial model of maker's "Vidicon" system of wired industrial television, incorporates numerous technical improvements over maker's older models of industrial TV systems which have been supplied in small quantities on high-priority orders. New camera contains new "Vidicon" photoconductive camera tube, almost as sensitive as studio-type "Orthicon" tube. Entire equipment consists of: (1) camera, weighing 7.5 lbs. and about the size of a 16mm movie camera; (2) combination 10-in.-screen monitor, power supply, and control unit housed in portable case smaller than a home table model TV set; (3) a length of 0.625-in. 18-conductor camera cable. Entire "ITV-5" system uses 22 electron tubes, less than half number used in maker's first (1947) industrial TV chain. High-quality pictures can be obtained without excessive illumination. Scanning frequencies are 525 lines, 30 fields, 60 frames, interlaced, per second —same as those of standard broadcast TV. Home TV sets can be used with new system as auxiliary viewers. Equipment can also be operated with microwave transmission from camera to receiver over extended distances. New system operates from ordinary 115-v. a.c. supply, is completely self-contained. Power consumption 230 watts.—*Engineering Products Div., RCA, Camden, N. J.*



Mention No. 1406 when filling out card.

Continuous Thickness Gage for Hot Steel Strip

New "Steel Mill Width Gage," a noncontacting system which continuously measures width of hot strip steel to 1/8-in. accuracy, is said to be "the first equipment of its kind ever developed." Gasket-sealed detector head mounted 15 ft. above hot strip steel has two phototube scanners whose output signals (two pulsating square-waves) are each amplified, added together, and balanced



HIGH CAPACITY

Duo-Seal® Vacuum Pump

5 Cubic Feet (140 Liters) Per Min.

GUARANTEED VACUUM

0.0001 mm Hg. or 0.1 Micron

WELCH DUO-SEAL PUMPS

No. 1402-B

This new two-stage Duo-Seal pump is constructed with the same care and precision as its fore-runners in the Duo-Seal line. The extremely quiet operation, so much appreciated in the other models, is also characteristic of this unit.

A positive oil seal prevents the oil from backing into the exhaust line. Oil may be changed in a few minutes due to the conveniently located oil drain.

- FASTER PUMPING
- QUIET OPERATION
- VISIBLE OIL LEVEL
- COMPACT DESIGN

Overall dimensions for pump and motor 15½" high and 11" wide x 19⅝" long.

Available for Immediate Shipment.

1402. DUO-SEAL TWO STAGE VACUUM PUMP. Pump unit only, not mounted on a base, but with a 10 inch grooved pulley, a supply of oil, and directions for use. **Each $190.00**

1402B. DUO-SEAL PUMP, MOTOR-DRIVEN. A No. 1402 Pump mounted on a base with a ½ H.P. 115-volt A.C. motor. Complete with pulleys, belt, and cord. **Each $250.00**

1402BG. BELT GUARD for 1402B Duo-Seal Pump. **Each $15.00**

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

Established 1880

1515 SEDGWICK STREET DEPT. B

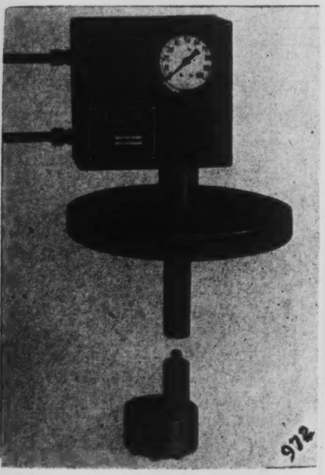
CHICAGO 10, ILLINOIS U. S. A.

against a standard voltage so that difference produces a signal proportional to width deviation. Operator's cabinet contains a three-digit mechanical counter type indicator of basic (pre-set) width, a deviation indicator, and requisite controls and switches for setting basic width and making occasional calibration checks. In use, operator sets width indicator, causing detectors to be automatically positioned over strip edges by a motor-driven lead screw. Another cabinet contains a deviation indicator plus majority of electronic components of system. Optional equipment includes extra deviation indicators plus a deviation recorder for remote mounting. Strip width of 10 to 96 in. can be measured at temperatures of 1350 to 2050 F. and indicated in less than one second after strip passes under detector head. Strip position can change as much as 3 in. either vertically or horizontally without affecting accuracy. —*Special Products Section, General Electric Co., Schenectady 5, N. Y.*

Mention No. 1407 when filling out card.

Pressure Transmitter

New Pressure Transmitter, for use with pneumatically-operated instruments, provides a positive seal and can be used with acids, alkalis, solvents, etc. System includes a diaphragm exposed to fluid to be measured: fluid's pressure on outer side of diaphragm is continuously and automatically balanced by air pressure supplied to inner side; and this air pressure is transmitted to receiver (or receivers) selected by user. Accuracy is plus or minus 0.25 in. of water on vented tanks and 0.5 in. on pressurized tanks. Transmitter is available (1) with flange mounting, for use with diaphragm inside tank, and (2) with a union connection, for use with diaphragm outside tank. Both types can be furnished for mounting at top, bottom, or side of tank. In addition, a combined liquid-pressure and equalizer unit is available for measuring liquid in pressurized tanks. Standard transmitters have a pressure range 0 to 45 psi.; withstand overpressures of 250 psi.; use less than 4 scfh. of instrument air at 70 psi. or higher.—*King Engineering Corp., Ann Arbor, Mich.*



Mention No. 1408 when filling out card.

Pressure Pickups

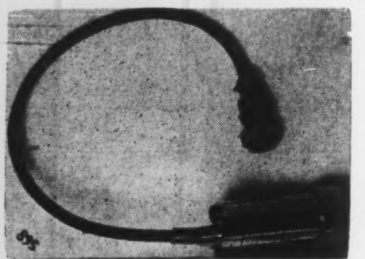
New "Model D Pressure Transducers" comprise a stainless steel Bourdon primary measuring element, a voltage-dividing resistor, anti-damage limit stops, and (for differential applications) a Neoprene diaphragm. Fourteen standard ranges: 0-20 to 0-2000 psi. Normal travel 0.340 plus-or-minus 0.015 in. Full ranges and recording ranges in ohms: 0-500 (25-475), 0-2000 (100-1900), and 0-5000 (250-4750). Tolerances, plus-or-minus 5 percent. Power rating, one watt. Units are corrosion-resistant, have standard tube fittings and a Winchester connector for electrical outlet.—*Servonic Instruments, 1193 W. Second St., Pomona, Calif.*

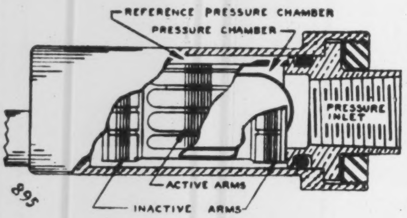
SERVONIC
PRESSURE TRANSDUCER
SERVONIC
PRESSURE TRANSDUCER
890
Single pressure
Differential pressure

Mention No. 1409 when filling out card.

Pressure Pickup

New "Type 4-301 Pressure Transducer" is for measuring pressure surges and high-frequency pulsations as well as static or slowly-varying pressures over an extremely wide temperature range in both gaseous and liquid systems. Rigid construction minimizes effects of accelerations in any direction and enables pickup to be used in field-testing aircraft and vehicles under operating conditions. Output is linear within 0.5 percent of full-scale value. Owing to high safety factor, overloads many times full-scale rated pressure range will not cause mechanical failure. Pressure-responsive element is a cylinder, about whose fluted expansible mid-portion are wound the active arms of a 4-arm bridge circuit, while reference arms are wound on practically-inexpansible ends. This element's expansion or contraction changes resistance of bridge arms and resulting bridge-unbalance voltage, proportional to any pressure change, can be fed to indicating or recording instruments. Pickup, complete with cable and plug, weighs 9 oz. Heavily-plated aluminum body adapts it to many high-moisture applications. Initial units are designed for 10-psig operation; later models will be available in ranges to 5000 psig. and materials suited for corrosive fluids.—*Consolidated Engineering Corp., Pasadena 8, Calif.*





Mention No. 1410 when filling out card.

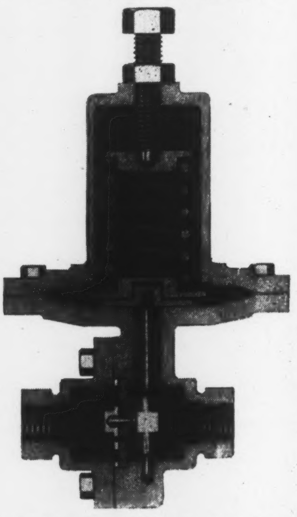
Pressure Pickup

New "Type 3CF Electrokinetic Pressure Transducer" is similar in appearance to "Type 3" illustrated and described in last month's issue (page 1378) but incorporates, in rear portion of case, a subminiature tube wired as a cathode follower. This modification is advantageous where a long cable is used and where it is impracticable to incorporate a cathode follower near pickup.—*The Beta Corp., P.O. Box 8625, Richmond 26, Va.*

Mention No. 1411 when filling out card.

Pressure-reducing Valve

New automatic pressure reducing valve, said to be "altogether different in principle and design" from any other on the market, consists of a bronze body, a stainless-steel gate that slides on a stainless steel plate, a phosphor-bronze diaphragm and stainless-steel small parts. It can be installed in any position, provides complete dead-end service and tight shut-off, is self-cleaning and unaffected by sediment. Available in sizes from ¼ in. to 2 in., for 150 psi. and 400 F. maximum steam temperature; takes any inlet pressure up to 250 psi. for water or air service; will provide reduced pressure as low as 2 psi.—*Jordan Regulator Corporation, Lebanon, Ohio.*



Mention No. 1412 when filling out card.

Pressure Regulator and Filter

New combination pressure regulator and filter permits line pressures up to 150 psi. to be reduced to regulated output pressure from 0 to 35 psi. without appreciable drift or air consumption. Filter and dripwell, accessible for easy removal and servicing, assures clean supply of air for pneumatic instruments.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 1413 when filling out card.

Pressure-reducing Regulator and Gage

New combination reducing regulating valve and pressure gage, for compressed-air purposes, is furnished in ¼, ⅜, ½ and ¾ pipe size connections. It regulates all secondary pressures to 150 psi. Bracket and two vibration dampers are furnished with each regulator and gage.—*Dayton Rogers Mfg. Co., Minneapolis 7, Minn.*

Mention No. 1414 when filling out card.

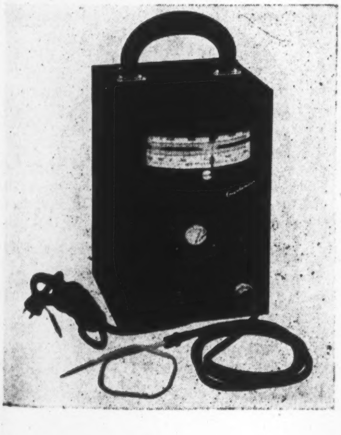
Inspector's Pressure Gage

New "Model P Test Gauge" is a 6-in. pressure gage guaranteed accurate to 0.5 percent of total scale at any point throughout range. Available ranges 0-30 in. vacuum to 0-10,000 psi. Measuring element is a full 270-degree Bourdon spring of steel or beryllium copper. Movement consists of a chrome-plated steel pinion, segment and arbor, Monel plates and a stainless steel hairspring. Stainless steel pointer is micrometer-adjusted. Leather carrying case, with shoulder strap, is optional.—*The Foxboro Co., Foxboro, Mass.*

Mention No. 1415 when filling out card.

Portable Temperature Controller

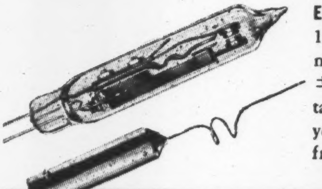
New "Guardsman" is a portable precision temperature controller for laboratories, research and testing companies and firms which require intermittent use of control instruments at different locations. Outstanding feature is that magnetic amplification replaces



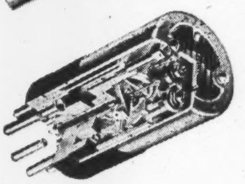
EDISON

AUTOMATIC CONTROL COMPONENTS

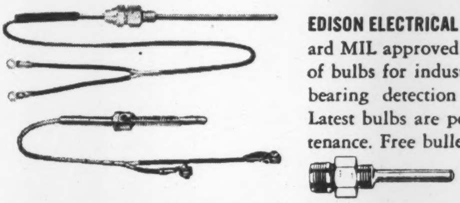
EDISON THERMAL TIMING RELAYS. Complete range of time delays from 2 seconds to 300 seconds within tolerance of ± 15% guaranteed for full life of relay. Standard RMA heater voltages. Both standard size and miniature relays meet shock, vibration and environmental requirements for aircraft application. Ask for free bulletins #3007 and 3027.



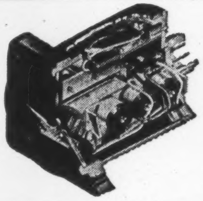
EDISON SEALED THERMOSTATS. Sealed-in-glass types break 115 volt 8 ampere *direct current* load with practically no contact arc. Type S1-1A holds control point within ± 0.1° over years without drift or apparent wear. Contacts cannot film or become contaminated even after years of inactivity as in fire alarm service. Write for free bulletin #3009.



EDISON SENSITIVE MAGNETIC RELAYS. SPST or SPDT contact arrangement—operate directly from d.c. current as low as 75 micro-amps. Contacts carry ⅓ amp non-inductive load. Copper-wound coils absorb overload to 10,000 times rated power. Separate coil leads to pins permit series or differential hookup. Send for free bulletin #3004.



EDISON ELECTRICAL RESISTANCE BULBS include the standard MIL approved types for aircraft and a wide variety of bulbs for industrial temperature alarm systems, hot bearing detection and process control applications. Latest bulbs are permanently sealed, require no maintenance. Free bulletin #3016.



EDISON TEMPERATURE INDICATORS. Full range of types and sizes, designed for rugged dependability, minimum weight. Ratio meter movement uses no hairsprings, delicate moving parts or large stationary magnets. Interchangeable parts simplify maintenance. Greatest spread in dial center speeds reading. Bulletin #3023.

MANUFACTURERS OF

Instruments & Fire Detection Systems
for Military & Commercial Aircraft

Thomas A. Edison
INCORPORATED
INSTRUMENT DIVISION
21 Lakeside Avenue, West Orange, New Jersey

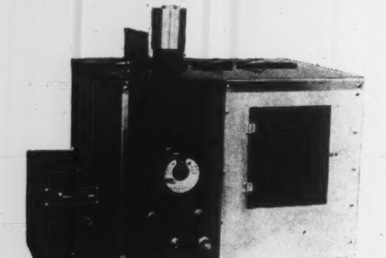
YOU CAN ALWAYS RELY ON EDISON

usual vacuum tubes, thereby assuring instantaneous starting and eliminating tube-failure interruptions. Temperature is indicated by upper pointer, controlled by setting lower pointer by means of external setting knob. Two power outlets enable instrument to control not only temperature but other factors. Thermocouple break protection prevents thermal system from overheating if a thermocouple should burn out or break. All models have a dual scale range of 0-500 F. (iron-Constantan) and 0-2000 F. (Chromel-Alumel), with a selector switch. Two six-foot thermocouples, one I-C and one C-A, are standard equipment. Three models: "JE" is on-off type; "JEP" incorporates same proportioning type control as in maker's standard proportioning controller; and "JEL" serves either as a high-limit or an "on-off" controller. In all models, telephone type relay is supplemented by an integral 1700-watt contactor permitting use of instruments directly on most load circuits.—*Taco West Corp., 525 N. Noble St., Chicago 22, Ill.*

Mention No. 1416 when filling out card.

Automatic Weighing and Sorting Scales

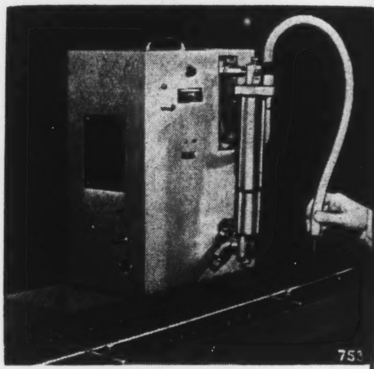
New models of "Metrogram" line of weighing instruments automatically sort pieces and packages, and classifies them by weight. A novel "pick-up and take-away" mechanism essentially duplicates hand method of placing pieces and packages on scale—which cycling may be easily synchronized with standard conveyors having relatively high speeds. Instrument rejects pieces or packages on over and under weights based on adjustable tolerance ranges which may be kept to extremely close limits of standard. Standards may vary from milligrams to pounds, and of practically unlimited physical size. Models are self-contained for either table or floor mounting.—*H. A. Hadley Associates, Inc., 41 Barlow St., Winooski, Vermont.*



Mention No. 1418 when filling out card.

Automatic Vial-filling Machine

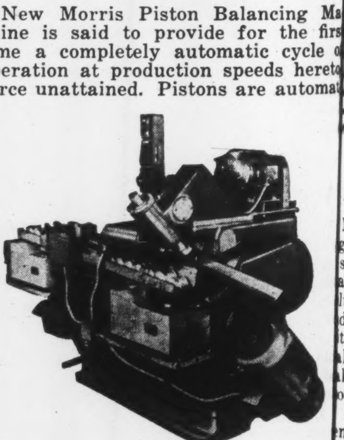
New "Filamatic Model AB 4 Automatic Pipette and Vial Filling Machine" fills up to 1200 4-oz vials per hour. Smaller volumes can be dispensed at speeds up to 90 per minute. It is designed for foam-free delivery of liquids into vials, ampoules and small containers including sprinkler neck bottles. Delivery volume can be varied from a single drop to 4 oz. per stroke and can be duplicated by setting micrometer reading to desired volume. Device is portable and may be operated wherever a source of current is available. An electric counter indicates total number of fills. Average accuracy of fill up to 0.1 percent regardless of variations in bottle size.—*National Instrument Co. 5005 Queensbury Ave., Baltimore* 15 *Md.*



Mention No. 1419 when filling out card.

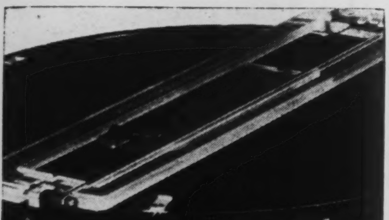
Automatic Piston-balancing Machine

New Morris Piston Balancing Machine is said to provide for the firs time a completely automatic cycle o operation at production speeds hereto force unattained. Pistons are automat ically fed to machine by gravity; fir pass a testing mechanism which d termines whether or not piston is proper position to be received by t machine. Pistons which are pass



Pictorial Position Indicator for Airplanes

New "Portable Pictorial Computer" is an automatic electromechanical airborne instrument for continuously indicating on a chart an airplane's position with respect to an omnibearing distance (OBD) station. It receives all necessary data concerning OBD station from an omnirange receiver and distance measuring equipment (DME). It consists of a display unit (illustrated) which may be held in pilot's or copilot's lap or mounted on instrument panel or a bulkhead, and an amplifier unit. Display unit weighs 10 lbs.; consists of fixed circular chart holder, position indicator assembly, control panel, and servomechanism. Chart holder accommodates specially-prepared 10-in. diam. aeronautical charts with OBD station at center. Position indicator assembly comprises a scale which slides in a cross guide which can rotate on surface of chart holder. A small hole at one end of scale indicates airplane's location. A lead pencil inserted into this hole marks position of airplane at any time, or traces airplane's course. Scale indicates distance from airplane along a line through OBD station. Bearings TO or FROM ground station are indicated by a 360-deg. azimuth scale. Servomechanisms in case below chart holder operate position-indicator assembly: two mechanical drives, one for bearing indication and one for distance indication. Amplifier unit (not illustrated) weighs 14.5 lbs. in 9x13x5 in. case.—*Aero Electronics Co., 1512 N. Wells St., Chicago 10, Ill.*



Mention No. 1417 when filling out card.

ove or to be initially weighed and eight graded. Pistons which are with- prescribed weight limits are gravity d to a second scale, where weight of ch piston is recorded and position at hich damped scale beam is locked termines depth of cut to be made milling cutter. Piston is then raised om scale to a cutting station where illing cutter is advanced along axis the piston internally. Piston pads e then trimmed to predetermined set- ng of scale beam so as to bring weight designed limit within plus-or-minus e gram.—*The Morris Machine Tool* ., *933 Harriet, Cincinnati, Ohio*

lention No. 1420 when filling out card.

All-metal Floating Thermometer

New all-metal floating dial-type ther- ometer can be read without removing om tank or vat, for constant check liquids during processing. It is con-

Weston
90
100
110
80
120
70
130
60
140
50
°F
150

ructed of stainless steel, with un- eakable window. It is regularly sup- ied with range of 50 to 150 F., and n. stem length (other ranges and ecial types can be provided). Accu- cy is 1 F.—*Weston Electrical Instru- ent Corp., 617 Frelinghuysen Ave., ewark, N. J.*

lention No. 1421 when filling out card.

Adjustable-span Recorder

New strip-chart recorder, for record- g a large number of variables, has span adjustment which permits full- ale pen travel to correspond to any ltage within a wide range of limits, d suppression adjustments which per- t shifting span upscale or down- le. External appearance is same as ker's "Type 153" except for six obs in a horizontal row near bottom door: (1, 2) Suppression adjust- nts (coarse and fine) provide linear an shift and make it unnecessary for rain-gage bridge or other actuating ment to be precisely balanced; zero n be anywhere on scale or can be oved off-scale. (3) Span adjustment thout change in zero setting; dial

10
0
10
SHALLCROSS

Interchangeable GALVANOMETER MOVEMENTS

MAKE DEFLECTION INSTRUMENTS

. . . Lighter in weight

. . . More Rugged

For precise null indication, more and more instrument designers are finding that Shallcross' new galvanometer movements pay big dividends.

For these new components make possible a number of instrument improvements through their unique construction. Instead of imbedding the mechanism in a large phenolic base, Shallcross mounts the taut suspension system on sturdy support rods. Result: a more rugged galvanometer —plus complete accessibility and lighter weight.

Designated Type 1951, these new galvanometer movements are available in standard sensitivities of 0.5, 1.0, 2.0, or 4.0 μa. per mm. scale division. They may be interchanged instantly with most movements in use today. The widely used 1.0 μa. model with 250 ohm coil is available from stock for immediate delivery. For full details on this as well as other models, write for Bulletin L-26.

SHALLCROSS MANUFACTURING CO., Collingdale, Pa.

Shallcross

SPECIAL
JERGUSON
WELDING PAD GAGES
are *integral* part
of this tank

Welding Pad Gages staggered on tank for continuous visibility.

HERE is a special line of gages that weld right to the liquid containing structure, thus becoming an integral part of it. It solves problems where it is impractical for you to use a conventional type gage because of solids in suspension in a liquid, etc.

These Special Gages follow Jerguson Standard Gages in general design and materials, except for the method of attaching. The chamber of the gage consists of a bar steel pad which is welded to the vessel.

Welding Pad Gages are made in both Reflex and Transparent types . . . in all sizes of Jerguson Standard Gages. Pressure ratings are available to your specific requirements. Welding pad may be of any metal desired to withstand corrosive or other conditions.

Write for Data Unit on Welding Pad Gages for complete details. Whatever your gage problems, let Jerguson engineers assist you.

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

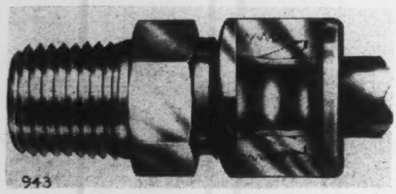
JERGUSON GAGE & VALVE COMPANY
100 Fellsway, Somerville 45, Mass.
Representatives in Major Cities
Phone Listed Under JERGUSON
Jerguson Tress Gage & Valve Co. Ltd., London, Eng.

permits full-scale travel of pen to correspond to any desired difference in millivoltage values within specified ranges. (4) Adjustment for sensitivity of amplifier which drives motor, pen and slidewire contactor: supplements gain control in amplifier and is used to match amplifier gain to recorder span. (5) Filtering and damping adjustment: introducing an added resistance into input circuit in series with source resistance, for removing spurious a-c. pickup signals, also for damping. (6) Standardizing adjustment.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 1422 when filling out card.

High-vacuum Tube Fittings

New design of "Swagelok" fittings provides a vacuum-tight seal (hold 10^{-7} mm.). Installation is accomplished with an ordinary wrench. Fittings are so designed that there is no torque on tubing to which fittings are attached, hence no hazard of other fittings on line twisting loose. Fittings are available in brass, aluminum, steel, stainless steel, and Monel.—*Crawford Fitting Co., 844 E. 140th St., Cleveland 10, Ohio.*



Mention No. 1423 when filling out card.

Short-time-cycle Relay for Temperature Control

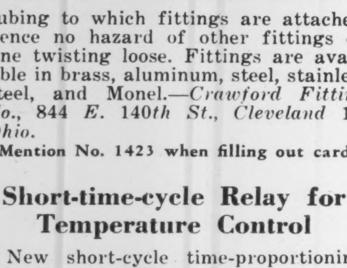
New short-cycle time-proportioning relay for controlling nylon heat setting, linoleum curing, and high-speed furnaces, has been added to maker's "Electr-O-Pulse" relay line to meet increase in number of processes having short time lags.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 1424 when filling out card.

Automatic Leak Tester

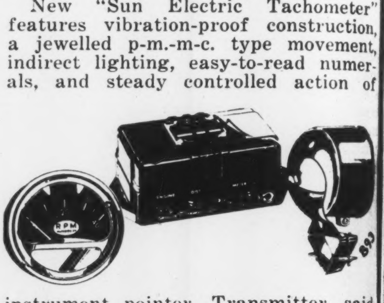
New automatic conveyerized pressure-testing machine checks cylinder-head water-jacket areas for leaks. It receives heads from a conveyer line, automatically seals them in three planes, checks for leaks by measuring air pressure loss, stamps OK, and delivers head back on conveyer. Machine is powered by a hydraulic pump driven by a 3-hp. motor.—*Modern Industrial Engineering Co., 14230 Birwood, Detroit 4, Mich.*

Mention No. 1425 when filling out card.



Auto and Truck Electric Tachometer

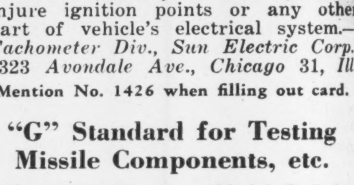
New "Sun Electric Tachometer" features vibration-proof construction, a jewelled p-m.-m-c. type movement, indirect lighting, easy-to-read numerals, and steady controlled action of instrument pointer. Transmitter, said to represent "the world's latest and most remarkable innovation in transmitter design," has no drive cable, and its only moving part is an "electric relay switch with solid silver contacts which will never wear out." Flashlight cell used in past models has been done away with. System does not draw current from battery of vehicle; cannot injure ignition points or any other part of vehicle's electrical system.—*Tachometer Div., Sun Electric Corp., 6323 Avondale Ave., Chicago 31, Ill.*



Mention No. 1426 when filling out card.

"G" Standard for Testing Missile Components, etc.

New 8-ft.-diameter "Model C G-Accelerator" is similar in arrangement and operation to 56-in.-diameter "Model B" (fully described in Aug. '51 *Instruments*, page 916). It incorporates optical, pneumatic and electrical systems combined for testing aircraft and guided-missile components of a larger size than heretofore possible. Test object can be seen as though stationary, regardless of rotational speed, through a telescopic optical system, permitting close observation at any time during testing. Hydraulic variable-speed transmission was chosen because of smoothness of operation, quietness and ability to maintain a given speed over long periods. An important feature for routine

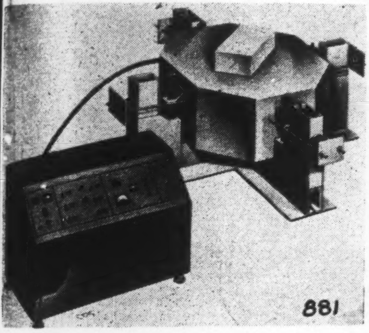


production testing is ability of tester to return to a preset speed by use of starting switch only. Time to reach full speed from standstill is approx. 30 sec. Max. acceleration force is 2000 G-lbs., e.g., 100 lbs. at 20 G, 40 lbs. at 50 G, etc., with max. G of 75.—*Dep't I, Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

Mention No. 1427 when filling out card.

Three-direction Mechanical Oscillator and Tester

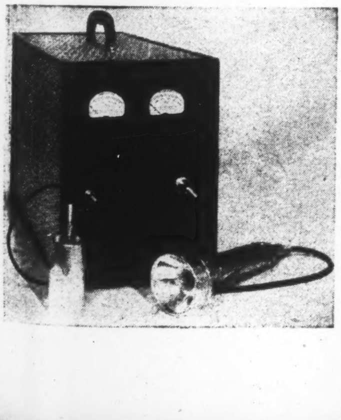
New "Space Oscillator" produces one-, two- or three-directional mechanical vibrations, for fatigue testing of specimens and for determining dynamic characteristics of materials. Displacement, velocity and acceleration are continuously variable as to magnitude, direction and action line without interruption of test procedure or repositioning specimen. Apparatus produces pulsating forces or moments for testing dynamic characteristics. Rated capacity, 2000 lbs. at 15 cps. and 1000 lbs. at 60 cps., with proportionately smaller forces over range of 3.5 to 15 cps. Amplitudes varying from zero to 0.5 inch are obtainable; in resonant range, dynamic amplification factor yields amplitudes and forces far in excess of those stated. An experimental machine has achieved double amplitudes of 24 in. Complete apparatus consists of oscillator, vibration table, and control console. All of variation in developed forces is controlled remotely, allowing operation in extreme-environment test chambers.—*Buck Engineering Co., Freehold, N. J.*



Mention No. 1428 when filling out card.

Dynamic Balancing Equipment

New "Model 652 Vibratron" portable system for analysis, evaluation, and correction of vibration, indicates amplitude and frequency of vibration and,

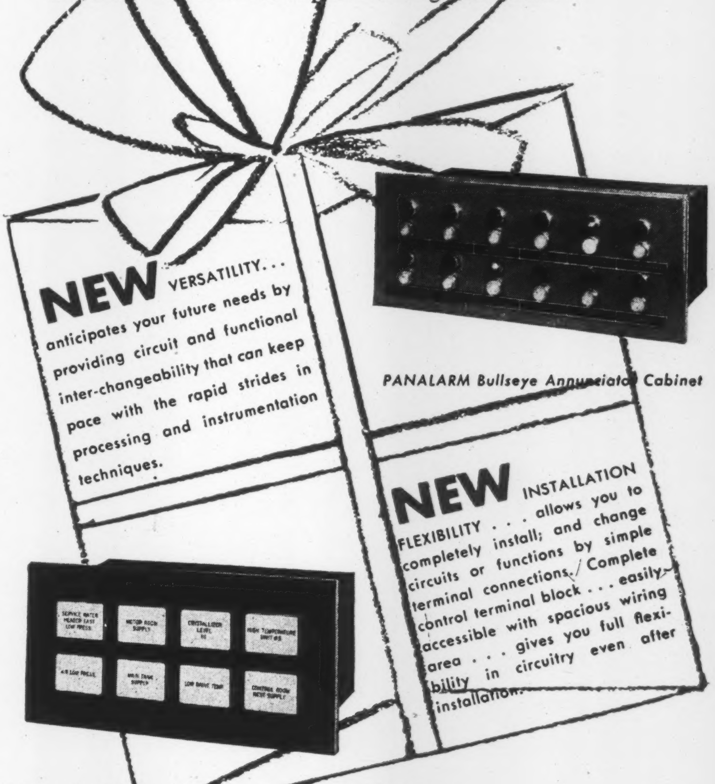


ANNOUNCING

NEW Universal PANALARM "50"

27 different functions...now provided by one standardized system

Just as PANALARM first introduced the hermetically sealed, plug-in annunciator system . . . NOW, PANALARM introduces Model "50" . . . a packaged system incorporating such significant advances that it obsoletes past thinking in the field.



NEW VERSATILITY... anticipates your future needs by providing circuit and functional inter-changeability that can keep pace with the rapid strides in processing and instrumentation techniques.

PANALARM Bullseye Annunciator Cabinet

NEW INSTALLATION FLEXIBILITY . . . allows you to completely install; and change circuits or functions by simple terminal connections. Complete control terminal block . . . easily accessible with spacious wiring area . . . gives you full flexibility in circuitry even after installation.

PANALARM Backlighted Name-plate Annunciator Cabinet

Write for
Catalog 100
New Universal PANALARM "50"
Annunciator Systems

NEW STANDARDS OF PERFORMANCE . . . give you the dependability you must have in an annunciator system. Sixty-three mechanical and electrical improvements combine to make the new PANALARM "50" the most practical annunciator system for everyday plant use.

With the greater dependence that *must* be placed on your annunciator system today . . . you should investigate the new PANALARM "50".

PANALARM PRODUCTS, INC.
6312 North Broadway • Chicago 40, Illinois

Copyright 1952—Panalarm Products, Inc.

are your
DELIVERIES
8
behind the
EIGHT BALL?
Servospeed
ELECTRONIC-MOTOR
SPEED CONTROL
IMMEDIATE
DELIVERY

- 110 volt and 220 volt models
- 1/100 to 1/10 horsepower
- Gear Head Motors
- Reversing and Dynamic Braking
- Constant Torque Output
- Continuous Duty Rated
- Reliable-Efficient-Economical

Other models available
to ¾ hp.

Servo-Tek
products co
4 Godwin Ave. Paterson, N. J.

NEW INSTRUMENTS

by means of a stroboscopic light, reveals source. It consists essentially of a vibration pickup, a multi-channel circuit, and a stroboscopic lamp. It operates on 110-v. ac. For production balancing, it can be integrated with a test stand for dynamic balancing of rotating parts in range from 600 to 40,000 rpm., or as a final step in balancing complete machines before shipment. By means of a 4-step switch in amplitude circuit, readings can be obtained in full-scale from 0.0001 to 0.1 in. peak-to-peak. New feature of "Model 652" is unusually rugged and sensitive velocity-type vibration pickup which will withstand repeated drops on concrete floors without loss of accuracy. Pickup output is 82 millivolts at 0.001-in. deflection at 60 cps. All components of "652," including electron tubes, are unconditionally guaranteed for two years. Cost includes personal delivery and operator training.—*Internat'l Research & Development Corp.*, 908 *W. Third Ave., Columbus* 8, *Ohio.*

Mention No. 1429 when filling out card.

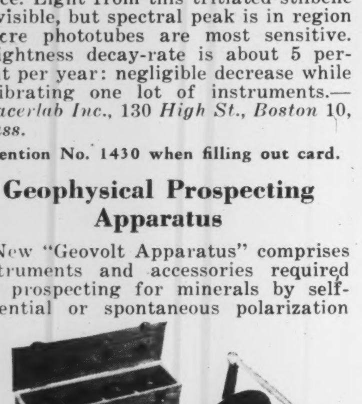
Constant-luminosity Source

New constant-luminous-emittance source, for calibrating instruments containing phototubes, and for scientific uses in astronomy, etc., is not a lamp but a luminescent material: tritium (triple-weight hydrogen) incorporated into stilbene and processed chemically to form a solid crystal. Tritium emits beta rays which cause stilbene to fluoresce. Light from this tritiated stilbene is visible, but spectral peak is in region where phototubes are most sensitive. Brightness decay-rate is about 5 percent per year: negligible decrease while calibrating one lot of instruments.—*Tracerlab Inc.*, 130 *High St., Boston* 10, *Mass.*

Mention No. 1430 when filling out card.

Geophysical Prospecting Apparatus

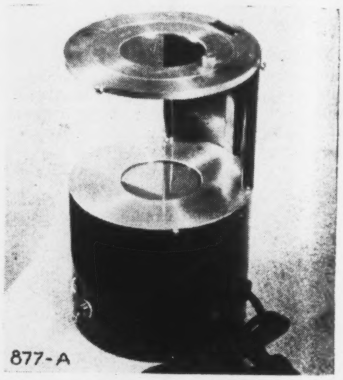
New "Geovolt Apparatus" comprises instruments and accessories required for prospecting for minerals by self-potential or spontaneous polarization method. In operation, geovoltage (natural earth voltage) is measured at a series of previously laid out stations. From these measurements a map is plotted. Point of maximum geovoltage on map is often directly over ore body. Complete apparatus consists of : (1) "Geovoltmeter," a rugged precision potentiometer for measuring geovoltage; (2) Set of four "Geotrodes" in a special carrier, for making polarization-free contact with earth; (3) lightweight reel; (4) 1,000 feet of "Geocable."—*Geographical Instrument Div., Georator Corp., Arlington* 9, *Va.*

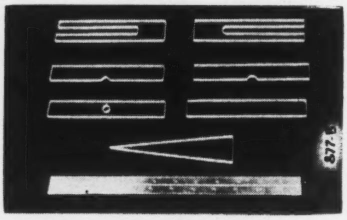


Mention No. 1431 when filling out card.

Photoelasticity Demonstrator

New "P-4 Polaroid Photoelastic Demonstration Apparatus" uses two 3-in. Polaroid disks to polarize light from a 25-watt bulb in base, and to analyze rays after passing through specimens. Size 6 in. diam., 12 in. high. New "P-3 Photoelastic Plastic Demonstration Specimens" are made of CR-39 resin with high refractive index, illustrate basic types of stress concentration.—*Ann Arbor Instrument Works*, 725 *Packard St., Ann Arbor, Mich.*

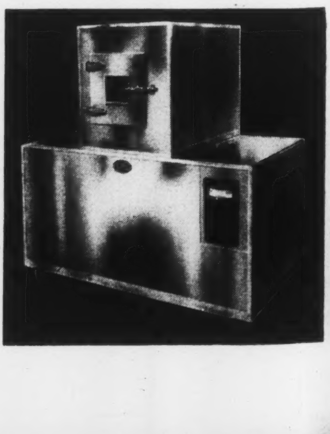




Mention No. 1432 when filling out card.

Production-line Test Chamber

New "A-4½-100 FHH" test chamber for production line and experimental testing has a temperature range from 250 F. down to —100 F.; can be cycled from ambient to —100 F. in 45 minutes and from —100 F. to 200 F. in 30 minutes. Temperature controller scale range is —200 F. to 400 F. with 3-deg.

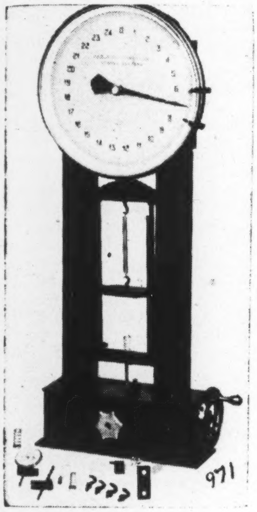


differential, 1.5-deg. plus and minus. Wet and dry bulb controller provides 95 percent relative humidity at temperatures between 75 F. and 95 F. Vacuum equipment can be added to simulate high altitude conditions. Test chamber is 20x20x20 in., 4.5 cu. ft.—*Industrial Freezer Div., Webber Appliance Co., 2740 Madison Ave., Indianapolis 3, Ind.*

Mention No. 1433 when filling out card.

Precision Spring Tester

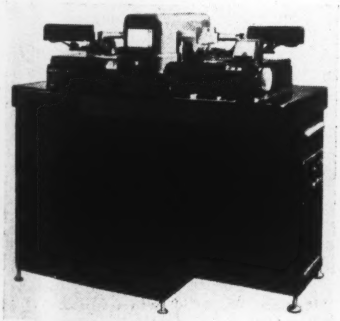
New precision spring tester measures loads and deflections of small compression and extension springs; capacity from ½ oz. to 25 lbs. Scale is accurate to within 0.25 percent, meeting NBS requirements. Steel rules measure lengths in 32nds and 64ths on one side and in decimals in 10ths and 100ths on reverse side. A 1-in. capacity dial indicator measuring to 0.001 in. is available. Speed from 250 to 500 tests per hour. Production stops and tolerance markers are easily adjustable. Springs with diameters up to 2 in. and lengths up to 10 in. can be tested.—*The Carlson Co., 277 Broadway, New York 7, N. Y.*



Mention No. 1434 when filling out card.

Double Piezo Crystal Orientation Unit

New double unit Quartz Orientation Instrument, of advanced design for higher precisions and far more rapid production of piezo crystals, meets to-



FOSTER MEANS . . .

It took a flood to knock it out! After 29 years of continuous trouble-free service in the water supply system of a northern New Jersey Township, this Foster 6" Type U Pressure Regulator was temporarily put out of service by a flash flood. A new Foster Type U Regulator is now on the job, and the old valve, factory overhauled, is now ready for many more years of service.

. . . and QUALITY means

Dependable, Trouble-free Service

To give dependable regulation, a valve must be able to meet service requirements without compromise.

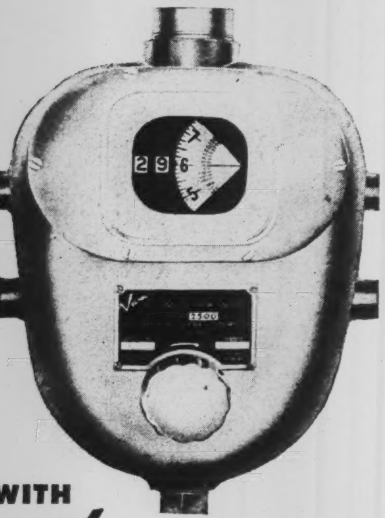
There is a specific type of Foster automatic valve for every service need. Each valve is engineered and built to do its job with a comfortable margin to spare, which means low maintenance.

This is the reason that Foster valves, over the years, have established a record for dependable performance second to none.

The next time you need a pressure regulator, it will pay you to tell the Foster Representative your requirements.

FOSTER ENGINEERING

SEE US AT THE POWER SHOW • NEW YORK • DECEMBER 1-6 • BOOTHS 38-39



Take the Guesswork out of Gauging

WITH "Varec" Fig. No. 2500

AUTOMATIC TANK GAUGE

FOR ALL TYPES OF LOW PRESSURE TANKS

Easiest To Install. Read. Operate. Maintain.

No oil tank should be considered properly equipped without a dependable, gas-tight automatic Tank Gauge! The new "VAREC" Figure No. 2500 Automatic Tank Gauge can eliminate the many errors of hand gauging and will, in addition, permit a host of time and money saving advantages.

The Fig. No. 2500 is also adapted for installation of "VAREC" Electronic Remote Reading Gauging equipment and Electronic Hi-Lo Limit or Controller Switches. Write today for full information or send coupon below!

Varec THE VAPOR RECOVERY SYSTEMS COMPANY

2820 N. Alameda Street, P. O. Box 231
Compton, California, U.S.A.

MAIL COUPON NOW FOR NEW BULLETIN CP-3500

THE VAPOR RECOVERY SYSTEMS CO.
2820 N. Alameda Street, P.O. Box 231
Compton, California, U.S.A.

Company & Dept.________________
Name________________Title________________
Street and No.________________
City and State________________

25-3

day's exacting specifications covering oscillator plates. Two-position desk provides knee room to comfortably accommodate operators facing each other. Controls and indicators are located to facilitate high output. Measurements in quartz orientation can be held to tolerances of half a minute of arc. An improved x-ray tube with mica beryllium windows is said to provide excellent intensity levels and to permit operation at low energy levels assuring long tube life and low operating costs. Goniometer radius is 15 cm.; angular range is from zero to plus 90 degrees. Scanning range is 5 degrees on either side of any selected Bragg angle. Settings are simplified and resetting is speeded by drop-in pins which can be utilized for angular positions which are used most frequently. Angles can be read direct on 3 drums.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.*

Mention No. 1435 when filling out card.

Radiac Detector Charger

New "Model XA-100" radiac detector charger, for charging pen-type fibre dosimeter, is self-contained and does not require tubes or batteries. Polarity depends on direction of rotation; hence if a dosimeter is overcharged, it may be zeroed by changing direction of turning. Delivers a current of 10^{-8} amp. at output voltage up to 3,000 v., positive or negative.—*Chatham Electronics Corp., 475 Washington St., Newark 2, N. J.*

CHATHAM ELECTRONICS
RADIAC DETECTOR
CHARGER
837

Mention No. 1436 when filling out card.

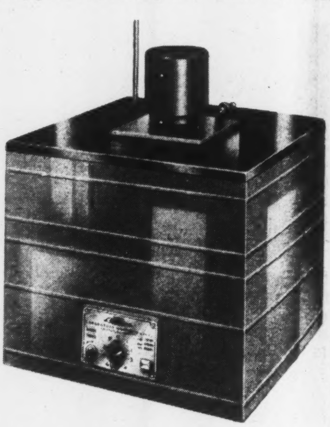
Multiplier Phototube

New "6199" small 10-stage multiplier phototube of head-on type is intended for use in scintillation counters and in other applications involving low-level, large-area light sources. Spectral response covers range from about 3000 to 6200 Angstroms with a peak at approx. 4000 Angstroms. Semi-transparent cathode has diameter of 1-1/4 in. on inner surface of face end of bulb; face has 1-in.-diam. flat surface to facilitate mounting flat phosphor crystals. Relatively large cathode area permits efficient collection of light from excited phosphor crystals employed in scintillation counters. Because of excellent optical coupling between phosphor and cathode, discrimination against dark-current pulses is facilitated.—*Tube Dep't., Radio Corporation of America, Harrison, N. J.*

Mention No. 1437 when filling out card.

Constant-temperature Circulating Systems

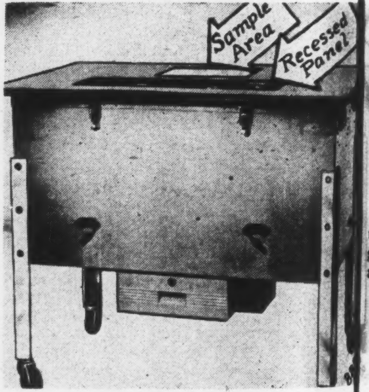
New systems are announced for cir culating liquids at controlled tempera tures through refractometers, viscom eters, polarimeters, etc. "Cat. No. 3052" is sensitive to 0.02 C., is easily set t desired temperatures through "Rota Set" mercury regulator. "Cat. No. 3050" is sensitive to 0.25 C. Features includ stainless steel throughout, all-bronz centrifugal pump, sealed ball-bearin motor, built-in cooling coil, and larg water capacity for greater stabilit Range below room to 100 C. Immediat delivery.—*Labline, Inc., 217 N. Des plaines St., Chicago 6, Ill.*



Mention No. 1438 when filling out card.

Large-area Colorimeter

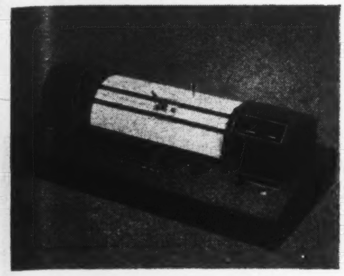
New large-area colorimeter, for meas uring effectiveness of detergents, i of design baked on maker's "Color an Color Difference Meter," major alte ation being in large size (9 x 12 in.) o sample exposure head, which allows a curate measurement in spite of non uniformity of soil on samples. It is als equipped with special filters which ma be used to eliminate any ultraviolet ra diation from tungsten light source fo measuring detergent properties wit out including effects of the fluoresce dyes. Other special features include special ultraviolet source for accent ating effects of fluorescent dyes, an a special measuring circuit for readi blue reflectance.—*Gardner Laborator Inc., Bethesda 14, Maryland.*

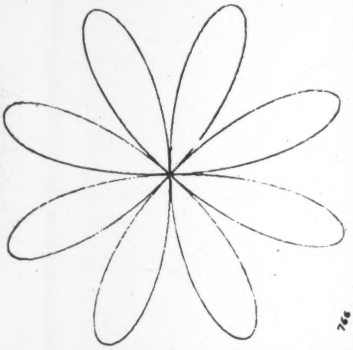


Mention No. 1439 when filling out card.

Digital Graph Plotter

New "Logrinc Digital Graph Plotter" automatically plots one variable against another algebraically in discrete steps, at a speed of 20 steps per second in all four directions, in response to pulses from digital-output primary measuring elements, intermediate elements, or electronic digital computers. Paper size: 12 in. on y-movement, 18 in. on x-movement; or longer continuous strip 12 in. wide. Step size is accurately 1/64 in. with no accumulative error, x and y axes being controlled independently by precision ratchet devices.—*Logistic Research Co., 141 S. Pacific Ave., Redondo Beach, Calif.*



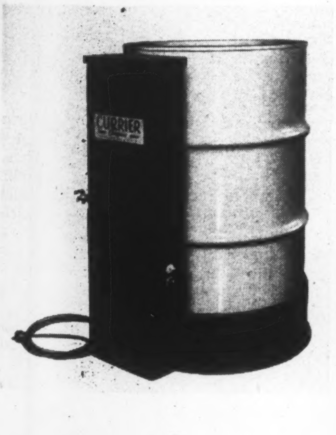


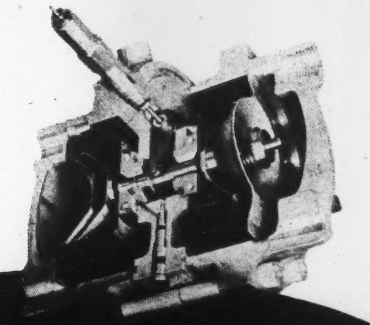
Plot made by Logrinc Digital Graph Plotter connected to a digital differential analyzer solving equation
$r = a \sin(4\theta)$ (1/6 actual size)

Mention No. 1440 when filling out card.

Vapor Degreaser

New "Drum Major" vapor degreaser uses readily-replaceable standard 55-gal. steel drum for cleaning tank, and any vapor solvent instead of flammable





MORE COST-SAVING ADVANTAGES

with

BARTON FLOWMETERS

The important difference lies in
BARTON'S PATENTED*
DUAL *RUPTURE-PROOF* BELLOWS PRINCIPLE

The Barton patented* Meter Body (see cutaway) eliminates all the principal sources of costly and troublesome flow measurement problems. You can throw away your mercury type meters...*actually save money by installing Barton Flowmeters.*

Barton dual stainless steel bellows are *rupture-proof.* Over-range damage is eliminated. The Barton actuating element is more compact and rugged, yet highly sensitive, insuring a long life of sustained accuracy with response that is virtually instantaneous.

Pulsation dampener, adjustable externally, controls rapidity of instrument response, eliminates pen flutter. Torque tube drive insures absence of leakage and friction for life of the meter, providing permanently a high degree of accuracy and sensitivity. The meter is completely self-draining or venting, eliminating the need for seal pots when measuring wet gases.

Thousands of Barton instruments are now employed throughout industry, solving measurement problems by combining top performance with cost-cutting efficiency. Write for complete information today...request Barton Bulletin 11C-4.

PRECISION-ENGINEERED FOR

... faster response
... sustained accuracy
... lowest maintenance

★

COST-REDUCING FEATURES...

- No Mercury
- No Seal Pots
- No Leveling
- No Cleaning
- No Over-range Damage

for measuring
FLOW • LIQUID LEVEL • DIFFERENTIAL PRESSURE
*Pat. Nos. 2400048, 2500360, 2590324, other patents pending.

BARTON INSTRUMENT CORPORATION

1431 SO. EASTERN AVENUE, LOS ANGELES 22, CALIFORNIA

Aerophysicists, Designers, Engineers

YOUR IDEAS WILL COUNT AT NORTH AMERICAN

North American encourages advanced thinking, because they know looking ahead is the only way to maintain leadership in the aviation industry. That's why North American needs men of vision. If you like hard thinking and would like to work for a company that will make the most of your ideas, you'll find real career opportunities at North American. North American offers you many extra benefits, too.

North American Extras—

Salaries commensurate with ability and experience • Paid vacations • A growing organization • Complete employee service program • Cost of living bonuses • Six paid holidays a year • Finest facilities and equipment • Excellent opportunities for advancement • Group insurance including family plan • Paid sick leave • Transportation and moving allowances • Educational refund program • Low-cost group health (including family) and accident and life insurance • A company 24 years young.

Write Today

Please write us for complete information on career opportunities at North American. Include a summary of your education, background and experience.

IS YOUR FIELD LISTED HERE?

Airborne Electronic Equipment
Equipment Flight Tests
Precision Instruments
Automatic Controls
Propulsion Systems
Servo-Mechanisms
Airframe Studies
Radar Devices
Instrumentation
Micro Wave Techniques
Metallurgical
Electroplating
Engineering Planning

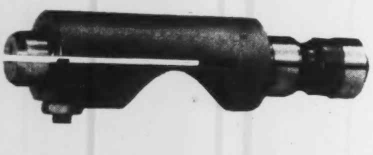
NORTH AMERICAN AVIATION, INC.
Aerophysics, Electro-Mechanical Research Division
Dept. 4, Personnel Section,
12214 Lakewood Blvd., Downey, California
North American Has Built More Airplanes Than Any Other Company In The World

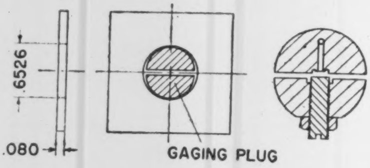
liquid solvents. Condenser and heating units are externally mounted; electric heating elements (3500-watt rating) are beneath drum bottom. Solvent can be recovered from sludge by simple distillation utilizing unit's own condenser. Thermostatic controls automatically maintain correct vapor level. Initial solvent charge, 5 gals. Drum is supplied with unit.—*Currier Co.*, 710—73rd *Ave., Oakland* 4, *Calif.*

Mention No. 1441 when filling out card.

Air-gaging Fixtures

New contact-type gaging fixtures, for measuring work which has coarse surface finish, are interchangeable in maker's standard "Pneumatic Comparator Gage" stands. Illustrated plug was supplied for measuring bores in which finish varied from 20 to 125 microinches. Upper part of fixture is rigid, contains a pneumatic measuring nozzle. Lower part is flexible, contains nozzle seat. When work is placed over end of plug, clearance between nozzle and nozzle seat corresponds to minimum diameter of bore. For calibration, standard ring gages are used as masters. Other fixtures are available for measuring maximum OD of coarse-finish parts. In both styles, nozzle is completely protected.—*Moore Products Co., H & Lycoming Sts., Philadelphia* 24, *Pa.*

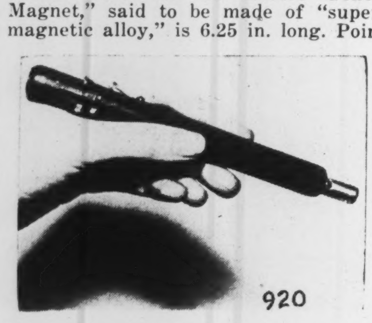




Mention No. 1442 when filling out card.

Pocket Magnet

New "G-S No. 15 Little Giant Magnet," said to be made of "supermagnetic alloy," is 6.25 in. long. Point of magnet is extended or retracted from a case by turning end-knob. Strength of magnet can be controlled by amount of extension.—*General Scientific Equipment Co.*, 2700 *W. Huntingdon St., Philadelphia* 32, *Pa.*



Mention No. 1443 when filling out card.

Gaging System

New "Micro-Step" Gaging System is an integrated series of gaging items said to make it easy "for the first time to use gage blocks directly in everyday gaging operations." New gage-block holders and end standards are used to construct innumerable gaging and layout setups up to 72 in. long in steps of 25 microinches; a "pre-calibrated" dial indicator is used with holders and end standards for constructing precise indicating type gages; other components include 5-in. and 10-in. sine plates, and a special book, "Height-Combination Tables - Heat Expansion Calculator," which lists gage blocks to be used in forming 10,000 different dimensions and which gives corrections to be made when checking non-steel parts with gage blocks at temperatures above or below 68 F.—*The DoALL Co., Des Plaines, Illinois.*

Mention No. 1444 when filling out card.

Volatile-fluid Dispenser

New "Automatic Dispenser," made of stainless steel, prevents evaporation of frequently-used volatile fluids, reduces fire hazard, saves time removing and replacing bottle stoppers. When user presses down on unit, fluid pumps up into dispensing dish. Amount is adjustable to from 3 to 15 drops per stroke. Six-ounce polyethylene plastic bottle is unbreakable and chemically inert.—*Menda Co.*, 279 *North Hill Ave., Pasadena* 4, *Calif.*

Mention No. 1445 when filling out card.

Large Contour Projector

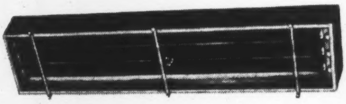
New "Taylor-Hobson 200-Inch Profile Projector" features two sets of precision optics and a 60-in.-diam. horizontal screen (viewing table), on

which tracings or templates can be mounted conveniently and under which remote controls for all adjustments are provided. Optics will give 20 to 100 times magnification for work up to 3 in. diam. For work up to 6 in., 10 times also is available. Delivery in 6 to 12 months.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

Mention No. 1446 when filling out card.

Industrial Ultraviolet Source

New "Blak-ray Model XXX-40" ultraviolet source, designed for industrial fluorescent inspection, processing, and packing operations, covers an area of

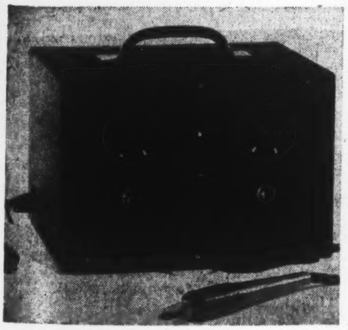


20 to 40 sq. ft. with intense non-injurious long-wave ultraviolet radiation. Fixture is dust-proof and vapor-proof, with a spectral-finish aluminum reflector for maximum UV intensity. These 40-watt "Blak-ray" tubes are rated at 3000 hours, burn cool, start instantly, may be turned on and off at will with no warm-up period for reaching peak UV emission and no cooling-off period required before re-starting.—*Ultra-Violet Products, Inc., 145 Pasadena Ave., South Pasadena, Calif.*

Mention No. 1447 when filling out card.

Soldering Unit

New "Model XK-72," aded to maker's line of soldering units, features an automatic timer (to 90 seconds) and an adjustable heat controller; is par-

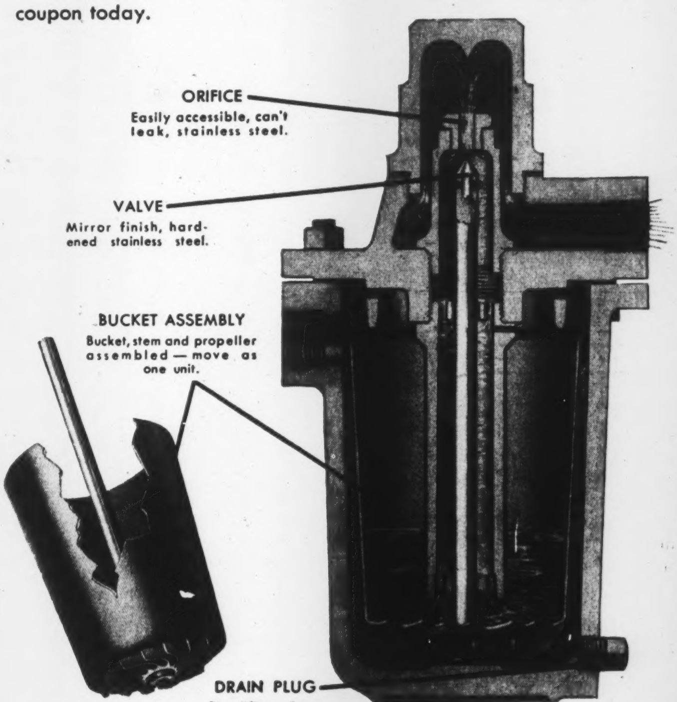


KEEP UPKEEP DOWN

no wire drawing with a TRERICE trap!

Wire drawing—a bugaboo for most traps—has been practically eliminated by the rotating valve feature of a Trerice trap. Bucket, valve stem and propeller—assembled as *one unit*—comprise the only moving part. Water action rotates the propeller causing the valve to seat differently in the orifice at each discharge. As a result, there's even wear all way 'round. Remember, too, you can completely inspect or service the valve and seat in a Trerice trap in a matter of minutes—without removing it from the line or disturbing high pressure bolts.

But—see for yourself! We'll be glad to provide a 60-day trial installation under your own conditions and without obligation. Send coupon today.


ORIFICE
Easily accessible, can't leak, stainless steel.
VALVE
Mirror finish, hardened stainless steel.
BUCKET ASSEMBLY
Bucket, stem and propeller assembled — move as one unit.
DRAIN PLUG
Simplifies cleaning and draining.

60-DAY TRIAL OFFER

Yes, I want to try the Trerice "Rotating Valve" trap for 60 days.
Trap Size__________ Pressure__________
Capacity Requirements__________
Application__________
NAME__________
COMPANY__________
CITY__________ ZONE____ STATE__________
2

H. O. TRERICE CO.
1420 W. LAFAYETTE BLVD
DETROIT 16, MICHIGAN
Manufacturers of Temperature Instruments

ENGRAVE
PANELS OF ANY DIMENSIONS IN YOUR OWN SHOP
with the Engravograph

Portable Model I-S
TRACER-GUIDED FOR UNSKILLED LABOR

The *only* portable machine which reproduces 15 sizes from one master alphabet.

The *only* one with *adjustable* copy holding slides for multiline engraving in one set-up.

Self-centering holding vise for nameplates

Send for Booklets
I-S-37—portable model • H-37—heavy duty model

NEW HERMES, Inc.
13-19 University Place, N.Y. 3, N.Y.
CANADA: 359 St. James St., Montreal

Fine
PRESSURE GAGES . . .

—must have a high degree of accuracy. They must be built to give long service. They must be easy to maintain.

In the Acragage you get these vital necessities, plus the Solid Front with full area blow out disc. If your gages are to be used on services where pulsation is the problem, the Acragage can be equipped with the Shockstop, the snubber that cannot plug and that never has to be cleaned.

Catalog M-50 tells all about the Acragage.

Send for your copy

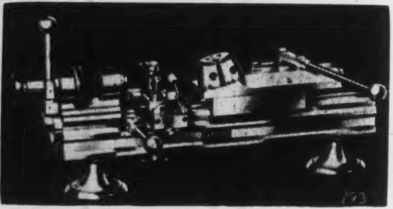
The ACRAGAGE Corporation
WAMPUS LANE • MILFORD, CONN.

ticularly suitable for fast precision soldering of instrument and circuit components.—*Sunrise Products Co., P. O. Box 173, Hawthorne, N. J.*

Mention No. 1448 when filling out card.

Turret Lathe for Instrument Parts

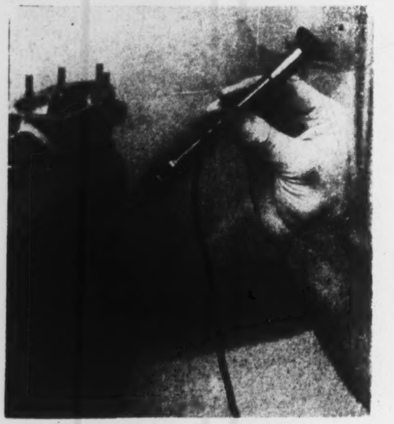
New bench turret lathe designed to handle small parts is made with two collet capacities, 3/16 or 5/16 in., is equipped with lever-operated collet closer, double tool cross slide with swivel compound slide, and self-indexing 6-position turret. Bed is 18 in. long. Turret head has 1/2-in. holes; turret slide is made of hardened steel.—*Louis Levin & Son, Inc., 782 East Pico Blvd., Los Angeles 21, Calif.*



Mention No. 1449 when filling out card.

Internal-inspection Borescope

New "Testa Borescope" has been developed for investigating and inspecting inside walls of surfaces of hollow castings, engine cylinders, crank cases, etc., accessible only through a small hole such as a spark-plug hole. Inserted tube is 0.5 in. diam., available in various lengths. Insertion depth for 0.5-in. hole is 7.5 in. less than total length of instrument. An aperture of 1.25 in. will allow inserting all but eye-cup. A set of twelve highly-corrected, achromatized, fluoride-coated lenses gives a field of vision of approx. 30 degrees (included angle). On inner end of lens system is an elliptical first-surface mirror whose angle can be adjusted to either side of its medium position of 45 degrees. In its normal position, mirror produces a view at right angle to tube. Magnification varies inversely as distance of mirror to inspected surface, from 6.25× at 3 in. to 2× at 12 in. Special frosted bulb is bright enough to illuminate even a dark surface at several inches. At 12 volts its life is 250 hours. If brighter illumination is desired, voltage can be put up to 18 volts, with 75-hour life.—*Testa Mfg. Co., 418 S. Pecan St., Los Angeles 33, Calif.*



Mention No. 1450 when filling out card.

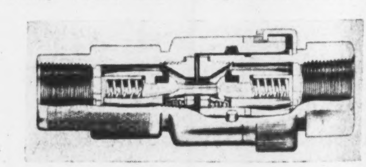
Illuminated Magnifier

New 10-power magnifier can be clipped to pocket like a fountain pen, uses two penlight batteries and bulb for illuminating object, weighs 2.5 oz. including batteries, employs a unique lens construction which allows light from bulb to go directly through lens and onto object without any direct light reaching user's eye.—*Bausch & Lomb Optical Co., Rochester, N. Y.*

Mention No. 1451 when filling out card.

Shut-off Coupling for Hydraulic or Air Lines

New "Wave-Flow" make and break double shut-off valved coupler, built originally for either ammonia or Freon refrigerants in connection with refrigerated trucks, has industrial application to pneumatic or hydraulic lines. As two halves are coupled together, the two piston valves open by moving away from their respective seats. A soft molded insert forms seat in each half. Alignment of pistons is insured by long guides. Pistons can be readily replaced after long service by unscrewing seat bushings. Protector caps are provided for covering coupler halves when disconnected. Available in ½-inch F.P.T. connections.—*Henry Valve Co., 3215 North Avenue, Melrose Park, Illinois.*



Mention No. 1452 when filling out card.

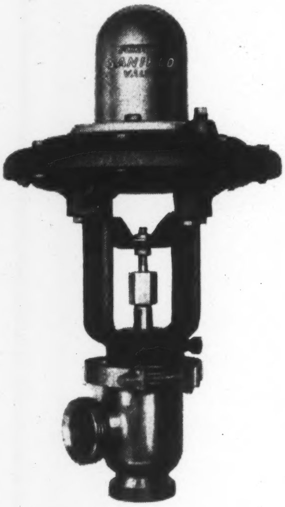
Projection Positive Paper

New "Kodagraph Projection Positive Paper," photographic paper for production of positive paper prints either through reduction or enlargement, can be used in a process camera to make direct-reduction positives from large drawings, or can be used with an enlarger to produce positive prints from positive microfilm records. It requires a special developer. It will, however, be available through all Kodak Industrial dealers.—*Eastman Kodak Co., Rochester 4, N. Y.*

Mention No. 1453 when filling out card.

Sanitary Control Valve

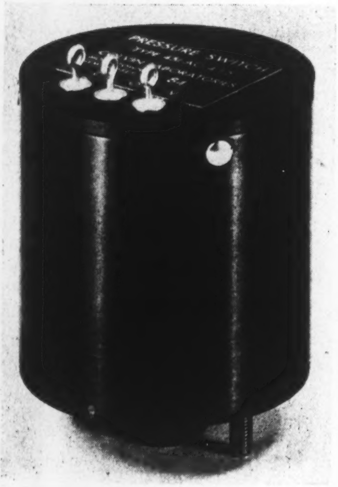
New "Saniflo," 2-way valve for sanitary control of food processing operations, features high flow capacity of an expanded "streamlined flow" body, friction-free power of "Stabilflo" diaphragm motor, and quick and easy disassembly for cleaning. All parts exposed to product are Type 18-8 corrosion-resistant stainless steel. Valve connections are 3A (IAMD thread), male, ground seat type. Available line sizes, 1 in. through 3 in.—*The Foxboro Co., Foxboro, Mass.*



Mention No. 1454 when filling out card.

Pressure Switches

New "Series 451" pressure switches incorporate relays which, with their associated mechanism, prevent contact chatter under any combination of pressure and vibration. Switches are diaphragm-operated and are available



DUPONT

OFFERS

INSTRUMENTATION

ENGINEERS

and

MECHANICS

Interesting Positions
REPAIRING, MAKING and CALIBRATING
Industrial Instruments

—on the Billion Dollar Savannah River Project,—an Atomic Materials Plant for the U.S. Atomic Energy Commission.

To engineers and mechanics qualified by experience, we invite your consideration of the following advantages:

- **54 Hr-Week, With Overtime Pay**
- **Opportunity to Add a Great Experience to Your Career**
- **Housing Assistance and Excellent Employee Industrial Relations Plan.**

For Further Information

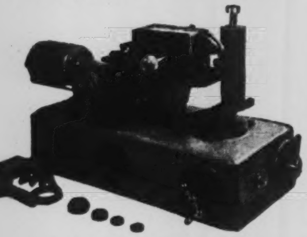
KINDLY WIRE OR MAIL US
YOUR NAME AND ADDRESS

E. I. du Pont de Nemours & Co., Inc.

Construction Recruitment Section

P.O. Box 117 **Augusta, Ga.**

MICO
Precision Apparatus
TOROID COIL



WINDERS

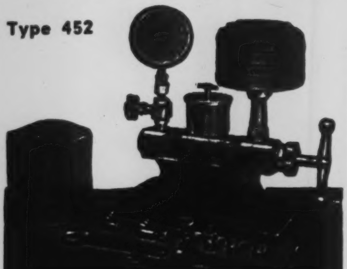
Flexible machines for your laboratory prototype development work.

Production machines built for volume manufacturing of specific coils.

MICO INSTRUMENT CO.
86A Trowbridge St., Cambridge, Mass.

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in 14 ranges, to 10,000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

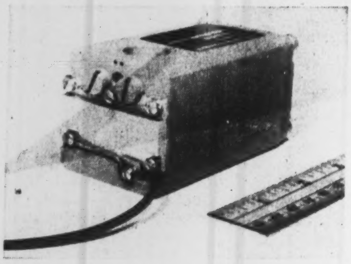
Amthor
Testing Instrument Co., Inc.
49a Van Sinderen Ave. Brooklyn, N. Y.

to make or break, or make and break, 5 amperes at any absolute or differential pressure up to 40 psi.—*Colvin Laboratories*, 12 *Court St., Morristown, N. J.*

Mention No. 1455 when filling out card.

Electrohydraulic Valve

New "PC-1 Pressure Control Servo Valve" is an electrohydraulic unit which converts milliampere signals to high-pressure changes for use in high-performance servomechanisms and automatic acceleration or force controllers.



Valve is actuated by two 700-ohm coils normally connected in opposition. Max. differential current required at 3000-psi. differential pressure is nominally 8 ma. Valve's horsepower rating is 4.2 hp.: 3.6 gpm. at 2000-psi. load.—*Standard Controls, Inc.*, 1431 23*rd Ave. South, Seattle* 44, *Wash.*

Mention No. 1456 when filling out card.

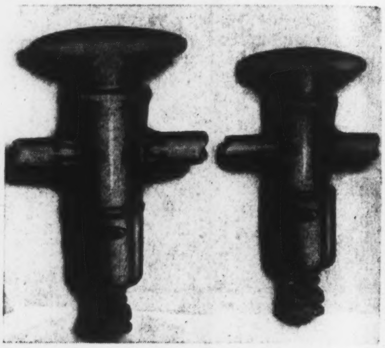
Cross-bar Generator

New "Model CB-101 Cross Bar Generator" for testing TV receivers and picture tubes, may be connected to several chassis points for adjustment data, or used as a test pattern source to modulate TV signal generators. It acts either receiver's video system so that horizontal or vertical lines are produced on picture-tube screen, or tests over-all response when used to modulate a TV signal generator. These lines are used to correct linearity and centering of images. It may also be connected directly to picture-tube pins so that tube operation may be checked without removal of receiver chassis from cabinet. — *United Technical Laboratories, Morristown, N. J.*

Mention No. 1457 when filling out card.

Stopcock Adapters

New Micro Size Adapters, for stopcocks of 2 mm. bore or less, have been added to maker's line to cover full range of laboratory stopcocks, so that any glass stopcock in a laboratory can be converted into a pressure-tight stopcock.—*Emil Greiner Co.*, 20-26 *N. Moore St., New York, N. Y.*



Mention No. 1458 when filling out card.

Tape Recorder

New low-priced "96-485 Knight" tape recorder is said to be excellent for recording conferences, training personnel, instantaneous recording of comments during time-motion studies, etc. Featuring piano-key type pushbuttons for selection of operating functions, it is easily used by all personnel. Operating functions include Fast Forward, Playback, Stop, Record and Fast Reverse. Fast Forward speed enables user to quickly locate portion of recording desired for playback.—*Allied Radio Corp.*, 833 *W. Jackson Blvd., Chicago* 7, *Ill.*

Mention No. 1459 when filling out card.

Instrument-lighting System

New fluorescent lighting is being made available as a standard option for various types of maker's industrial instruments and control-room panelboards. Lighting assembly includes a cool-burning white-daylight lamp, a starter for preheating lamp filament cathodes, and a ballast which limits current and voltage to a required value. In additon, a reflector ring is included in circular-chart instruments.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

Mention No. 1460 when filling out card.

Oscillograph Accessories

Two new features for maker's "PM-13" automatic oscillograph are announced: (1) Photographic time recorder which automatically records

year, month, day, hour, and minute when electrical disturbances occur; installed between top of "PM-13" case and record-paper holders. (2) New light-source which speeds and simplifies lamp changes. Does not require lens, prisms, and apertures, therefore light-source adjustments are no longer necessary when lamp is replaced periodically. Available as conversion kit for existing "PM-13" oscillographs.—*Meter & Instrument Dep't, General Electric Co., West Lynn* 3, *Mass.*

Mention No. 1461 when filling out card.

Cathode-ray Tubes

New line of cathode-ray tubes, employing electrostatic focus and magnetic deflection, are designed primarily for radar installations. "Types B1036P-, B1038P-, B1039P-, B1040P-, and B10-56P-," replace respectively "Types 5FP-, 10KP-, 12SP-, 12DP-A, and 7MP." Electron lens obviates necessity of focus coil. Tubes have much smaller power requirements than older tube types.—*Allen B. Du Mont Laboratories, Inc.,* 1500 *Main Ave., Clifton, N. J.*

Mention No. 1462 when filling out card.

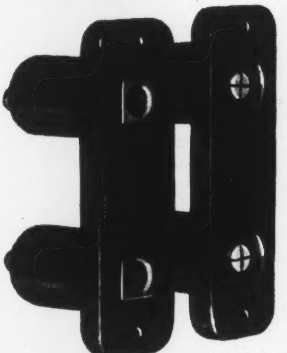
TV-servicing Oscilloscope

New "WO-88A" five-inch oscilloscope, for TV serviceman and industrial user, features numerous operating conveniences; includes a 10-megohm probe

CANNON PLUGS for laboratory and switchboard

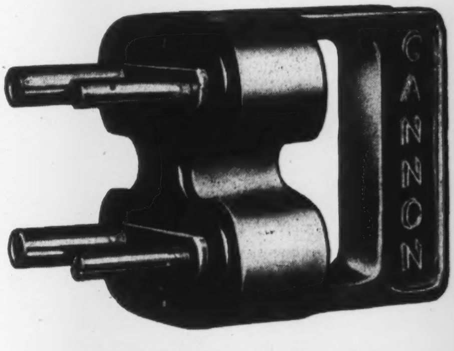
CSR Tandem Receptacle
CSP Plug

Here are a few examples of Cannon's Experimental Laboratory and Switchboard Connectors. They are used extensively throughout industry, public utilities, sound studios, broadcasting stations, college and university physics and chemistry laboratories, in AC network analyzers and electronic analog computers. They may be applied wherever quick disconnect switching and patch cord plugs are required. High grade materials are used throughout. Molded phenolic of high dielectric strength is used for insulation. Both pin and socket contacts are machined from solid brass. Some are silver plated. All are rated at 75 amps. Pin contacts are split for low loss seating in tapered bore sockets. Single contact fittings are supplied in either red or black phenolic to designate direct or alternating current circuits respectively. Two-contact and larger plugs have sand-blasted cast aluminum shells and handles with clear lacquer finish. Various combinations of pin and socket contacts are used as a polarizing guide. For further information write for Bulletin LS5-1951.

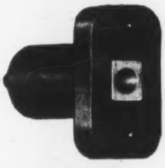


SDR Receptacle

SDP Receptacle



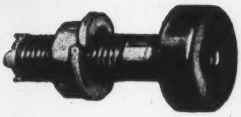
SWPR-4 Switching Plug having both pin and socket contacts



SR Receptacle

SCR Plug

SCP Plug



SRB Receptacle

CANNON ELECTRIC

Since 1915

Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. K-180 P. O. Box 75, Lincoln Heights Station, Los Angeles 31, Calif.

The *Accurate* Way to Measure Extreme Temperatures *at a glance*

The Simplified PYRO Optical Pyrometer

SELF-CONTAINED. No correction charts, no accessories, no up-keep. Direct-reading.

ACCURATE. Permits *close* and *rapid* temp. determination—even on *minute spots, fast-moving objects, smallest streams.* ("Special Foundry Type" and "Triple Range" also have RED Correction Scale for determining *true spout* and *pouring* temps. of molten iron, steel in the open.)

LIGHT IN WEIGHT—Only 3 lbs. complete. Handy.

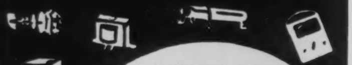
PROVED IN USE—Thousands in daily use.

Stock Ranges 1400°F. to 7500°F.

Write for FREE Catalog No. 80—also catalogs on other PYRO Pyrometers

THE PYROMETER INSTRUMENT CO.
Plant and Lab.
BERGENFIELD 4, NEW JERSEY
In Canada, Sales and Repair Laboratory:
Dominion Flow Meter Company Limited
Toronto and Montreal

WORLD'S FINEST IN-STOCK
INDUSTRIAL ELECTRONICS
PARTS CATALOG



RADIO SHACK
53
30

NEW 200-PAGE 1953 EDITION JUST PUBLISHED!

SENT FREE

Write on your company letterhead. Radio Shack's catalog is COMPLETE from AMPEX to ZEPHYR. Over 15,000 listings of components and equipment, plus details, pictures, lowest net prices. Separate indexing of products and manufacturers. Full JAN data! The preferred buying and reference guide for P.A.'s, engineers, designers, schools, civil defense, government, service agencies. *For your FREE copy, write TODAY to Department O.*

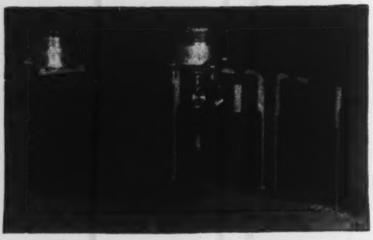
RADIO SHACK
CORPORATION
167 Washington St., Boston 8, Mass.

with an input capacitance of less than 10 uuf.; provides virtually perfect square-wave response up to 50 kc. Controls for push-pull balance and astigmatism adjustment are conveniently located outside cabinet. Simultaneous peak-to-peak voltage measurements and waveshape observations are made possible by a front panel terminal which provides a one-volt peak-to-peak reference voltage, and a green graph screen scaled in peak-to-peak voltage divisions. Deflection sensitivity 25 rms mv. or better per inch; frequency response flat from dc. to 500 kc. within minus 3 db and within -10 db at 1 Mc.; sweep-circuit frequency of 15 cps. to 30 kc. in four ranges.—*Tube Dept., RCA Victor Div., Camden, N. J.*

Mention No. 1463 when filling out card.

CRO Terminal Adapter

New "Type 2592" terminal adapter permits easier use of coaxial cables for carrying signals to banana-jack type terminals of CRO's and other test equipment and also provides correct impedance-matching termination for coaxial cables. It can be employed on any instrument having banana-jack type terminals spaced 0.75 in. on centers. Built into adapters are impedance-matching resistors. Currently available are 52-, 75-, and 93-ohm terminal adapters for use with UHF and BNC coaxial connectors and 52- and 75-ohm terminal adapters for use with Type N coaxial connectors.—*Instrument Div., Allen B. Du Mont Labs., Inc., 1500 Main Ave., Clifton, N. J.*



Mention No. 1464 when filling out card.

Ruggedized Electrical Indicating Instruments

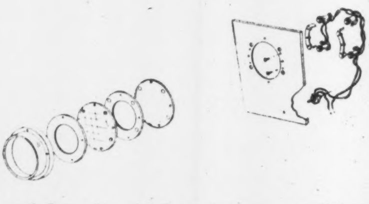
New design 2.5-in., 3.5-in. and 4.5-in. d-c. or rectifier-type a-c. indicating instruments meet MIL-M-6A, MIL-M-10304. Movement is shock-mounted in a low-temperature rubber compound and bonded to case, does not flop around under vibration or shock: design permits pointer and scale divisions to be easily read under vibration conditions. Internal pivot type construction: jewels mounted in a solid metal core, and pivots mechanically fastened on inside of coil. New type case has rear panel with screw terminals; is permanently hermetically sealed at factory but case design and neoprene gasket permit opening and resealing with simple tools. —*The Hickok Electrical Instrument Co.,* 10519 *Dupont Ave., Cleveland* 8, *Ohio.*

MILLIAMMETER

Mention No. 1465 when filling out card.

CRT Calibration Kit

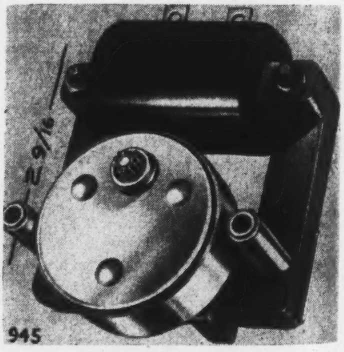
New "Type 2562 Illuminated Calibrated Scale Kit" facilitates amplitude and time calibration for both visual and photographic applications; is designed to fit any 5-inch CRO with maker's "Type 2501" bezel; is especially useful under darkened-room conditions or under a camera hood; consists of four incandescent bayonet type lamps with sockets, a bezel, front and rear masks, a plastic rectangular-coordinate calibrated-scale, and a color filter. Light from lamps is diffused throughout calibrated scale by means of four symmetrically-arranged depressions on scale. Kit also includes a dimmer control which may be mounted on CRO front panel.—*Instrument Div., Allen B. Du Mont Labs,* 1500 *Main Ave., Clifton, N. J.*



Mention No. 1466 when filling out card.

Appliance-timing Motor

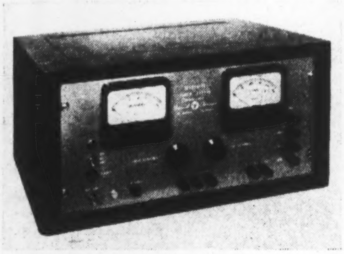
New "Model H-10 Telechron Synchronous Timing Motor," designed for appliances where automatic time cycling is required, has exceptionally high torque rating for intermittent load peaks of short duration: terminal speed of 3.6 rpm with a peak torque rating of 0.375 lb.-in. Other features: continuous lubrication, sealed gear train, light-weight rotors, and air-cooled coil. —*Telechron Dept., General Electric Co., Ashland, Mass.*



Mention No. 1467 when filling out card.

Regulated Power Supply

New "Model 300A" regulated power supply furnishes continuously-variable voltage from 0 to 500 volts d.c. at 0 to 300 ma. Bias voltage supplied can be varied from 0 to 150 volts at 2 ma. max. Also two independent outputs of low a-c. voltage to give either 6.3 v. at 6 amp. or 12.6 v. at 3 amps. Regulation: less than 0.2 volt variation of high voltage from no-load to full-load, or for line fluctuations from 105 to 125 volts. Hum voltage is 2 mv. rms. for any voltage or load within ratings. Internal impedance is less than 1 ohm for d.c. and less than 0.25 ohms from 20 cps. to 50 kc.—*Universal Electronics Co., 2012 S. Sepulveda Blvd., Los Angeles 25, Calif.*



Mention No. 1468 when filling out card.

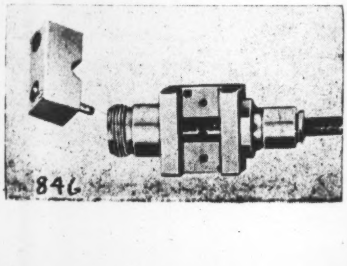
Pulse Generator

New "Mark 15 Model 47 Precision Pulser" is a pulse generator with an extremely short rise time pulse and a precise control of pulse amplitude. Pulse rise time is less than 10^{-8} seconds, fall time is 350 microseconds. Instrument has ranges of 1, 3, 10, 30 and 100 millivolt pulse amplitude with 10-turn linear pot control over these ranges. Pulse height is standardized against a standard cell in instrument. Repetition rate is 3600 pulses per second.—*Radiation Counter Labs., Inc., 5122 West Grove St., Skokie, Illinois.*

Mention No. 1469 when filling out card.

Coaxial Pads

New fixed coaxial pads are for application in circuits operating at frequencies from zero to 10,000 Mc.; 6-, 10-, and 20-db pads are available in conventional pi and T construction, utilizing metal-



Many products . . . One Standard

I.Q.*

*Instrument Quality

There is one characteristic common to all Giannini instruments—they are built to rigid, instrument-quality standards. They are instruments with an earned reputation of offering the utmost in mechanical and electrical fineness—resulting from outstanding craftsmanship and rigorous calibration, testing and inspection procedures. Your job requirements can be met or exceeded by Giannini IQ instruments.

For catalog and engineering data on these and other fine instruments write:

ACCELEROMETERS
Linear Transmitting

ANGULAR TRANSMITTERS
Pitch, Yaw, Pitot Static

GYROS
Free • Rate
Vertical • Directional

POTENTIOMETERS
Low Torque • Many types and resistance values

PRESSURE SWITCHES
Absolute • Differential
Gage

PRESSURE TRANSMITTERS
Absolute • Differential
Gage • (Resistance type)

STEPPING POSITIONERS
Intermittent Rotary Power

TEMPERATURE DEVICES
For high or low temperature

INSTRUMENTS CONTROLS

Giannini

G. M. GIANNINI & CO., INC., PASADENA, CALIFORNIA, EAST ORANGE, NEW JERSEY

F/C PNEUMATIC TRANSMITTER

Ideal for measurement of level, pressure, specific gravity and differential pressure.

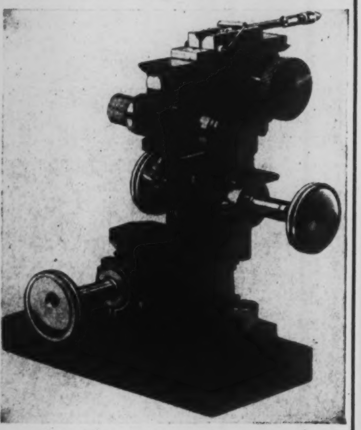
Materials available:
steel, bronze, stainless, Haveg, Hastelloy and Monel.

Non-overloading type diaphragm. Extreme accuracy. For high or low pressure.

Write for Illustrated Bulletin

INSTRUMENTS, INC.
122 N. Madison Tulsa 6, Okla.

MICRO MANIPULATORS
FOR TRANSISTOR WORK
MICRO-SOLDERING ETC.



Four Models To Choose From!
Immediate Delivery
Prices from $160.00

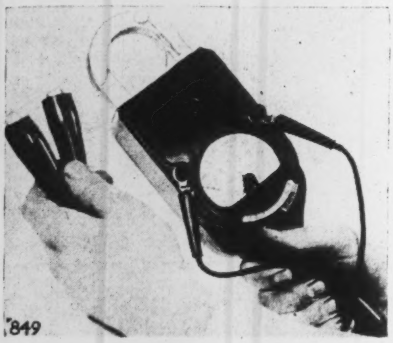
GAMMA INSTRUMENT CO., INC.
261-263 Great Neck Rd.
GREAT NECK, N. Y.

lized film resistors. Small size and rugged characteristics are said to render them useful in microwave circuits.—*Telewave Laboratories, Inc.*, 100 *Metropolitan Ave., Brooklyn* 11, *N. Y.*

Mention No. 1470 when filling out card.

Hook-on Volt-ammeter

New "Type AK-1A" redesigned hook-on volt-ammeter has higher voltage and current ranges and new pointer-stop mechanism. Measures alternating current on five scale ranges: 0-7.5/30/75/300/750 amp.; also alternating voltage on three ranges: 0-150/300/750 volts. Instrument is shielded magnetically. A dovetail joint on magnetic jaws reduces imperfect-closing errors to less than 2 percent where butt joint might cause errors as high as 10 percent.—*Meter and Instrument Dep't, General Electric Co., West Lynn* 3, *Mass.*

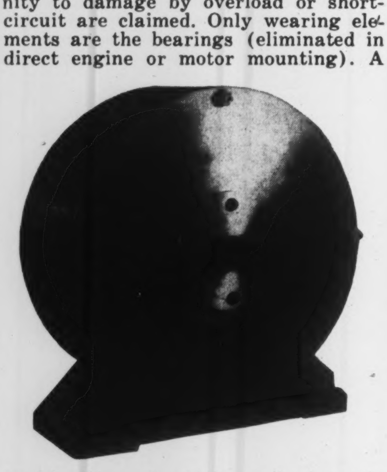


849

Mention No. 1471 when filling out card.

400-cps. Generators

New "Nobrush" generators are said to give a degree of ruggedness and simplicity heretofore unknown: cast aluminum rotor with permanent magnets mounted therein. Good wave form, high efficiency, cool operation, immunity to damage by overload or short-circuit are claimed. Only wearing elements are the bearings (eliminated in direct engine or motor mounting). A combination of static and dynamic shielding retains magnetism at a high level. Units are also available for 25, 50, 60, 180, 360, 800 and 900 cps. Any of usual voltages, single-phase, single-phase center-tap or three-phase can be supplied; also multiple coils, permitting connection in series or parallel to give different voltages; also tapped windings or separate low-voltage windings. —*Georator Corp., Arlington* 9, *Va.*



Mention No. 1472 when filling out card.

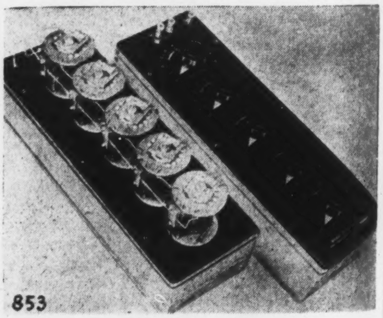
Snap-around Volt-ammeter

New "Amprobe 300" pocket-size volt-ammeter covers nine ranges: 0-6/15/30/60/150/300 amps. a.c., 0-150/300/600 volts a.c. New retractable safety plug on voltage test leads automatically insulates itself when removed. Jaws are completely insulated down into sockets; are pointed for working in crowded switch and terminal boxes. —*Pyramid Instrument Corp., Lynbrook, N. Y.*

Mention No. 1473 when filling out card.

Resistance Boxes

New "Type 750 Resistance Boxes" are complete assemblies of two or more "Type 275" high-precision decade units, mounted on a black alumilited panel and enclosed in a shielded walnut cabinet. Shielding consists of full copper lining making electrical contact with metal panel for complete isolation of the resistive elements (no electric circuit between shield and resistance elements). Three terminals are provided: two for resistance circuit; and a ground connection to shield. Maker's "knee-action" three-blade switch forms a short low-resistance path between contact and insulated collector ring. New precision boxes may be used as Laboratory Standards, as direct-reading resistor elements in bridge circuits, etc.—*The Daven Company*, 191 *Central Avenue, Newark, N. J.*

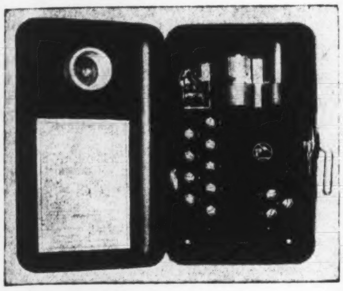


853

Mention No. 1474 when filling out card.

Photoelectric Controls

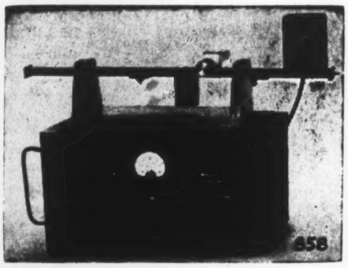
New "Series 20 and 21" photoelectric controls are adaptable to a wide variety of industrial applications. Phototube is available either integral with housing or in a small separate housing. Tamper-proof sensitivity adjustment permits positive operation over varying distances between phototube and light source.—*Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.*



Mention No. 1475 when filling out card.

Microwave Signal Sources

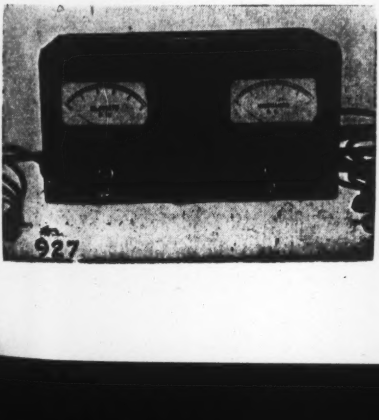
New "Centilators" are signal sources for microwaves from 1245 to 9960 Mc. Five units cover this range; each consists of a reflex klystron oscillator, an output transmission line system with an attenuator and a crystal detector, a sawtooth generator which provides signal for sweeping klystron frequency, and a regulated power supply. "Centilator 8596" has, in addition, a calibrated wavemeter for frequency measurement. "Centilators 6274 and 8596" use waveguide output; other models terminate in standard "N" type coaxial connectors.—*Kay Electric Co., Pine Brook, N. J.*

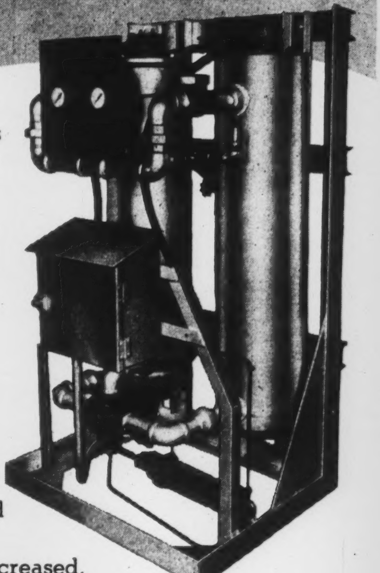


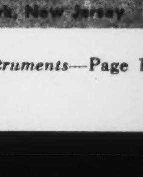
Mention No. 1476 when filling out card.

High-voltage Tester

New "Model 424 Hypot" is a d-c. high-voltage dielectric strength tester with continuously-variable voltage out-







Keep Instrument Air CLEAN and DRY with an Industrol DYNAMIC DEHUMIDIFIER

Backed by years of experience, INDUSTROL Dynamic Dehumidifiers have been especially designed to provide clean, dry instrument air, at low cost. With their use a drastic reduction of instrument maintenance is made possible. Costly instruments can last longer, operate at maximum efficiency.

Perfect heat distribution built into the design of these units assures excellent regeneration. To care for future needs, units are so designed that larger chambers can be installed with minimum effort and expense, should unit capacity need to be increased.

Industrol DYNAMIC Dehumidifiers offer these advantages:

- Simplicity of design
- Ease of installation
- Superior type of desiccant —easily replaced without dismantling unit
- Minimum maintenance
- Complete dependability
- Compact, economical, rugged
- Sizes—35 - 1500 cfm.
- Perfect regeneration—steam or electric

SEND FOR — new illustrated Bulletin DD-140 describing INDUSTROL Dehumidifiers and how to size a unit to fit your requirements.

2081

Industrol CORPORATION

Subsidiary of Trinity Equipment Corp.
494 Westfield Ave., East
Roselle Park, New Jersey

PREIS-PANTO
UTILITY ENGRAVER

- Ratios from 1.7:1 to 7:1
- Areas at 2:1 ratio —4-5/16" sq. 4½" circle
- Areas at 7:1 ratio —1⅛" sq. 1⅜" circle

A high precision, sturdily constructed, widely adaptable machine for engraving steel stamps, dies, other metals, plastics, fibre, wood, etc.

By simple attachment of additional accessories this machine may also be used for ELECTRICAL MARKING and ACID ETCHING.

Write for NEW Bulletin B-1 of the complete line and ask for catalog UE-3 with price lists.

PANTO

H.P. PREIS Engraving Machine Co.
661 State H'Way 29 Hillside, N. J.

FILL DESIGN & LETTERING WITH COLOR

This Bench unit applies ink, paint or enamel colors to depressed or sunken surafces—Ask for the

ACROPRINTER (Reg. U.S. Pat. Off.)

STAMP NAME-PLATES

of steel, other metals or plastic with this fast operating

ACROMARKER NAME PLATE STAMPING MACHINE.

Write for latest illustrated literature

The ACROMARK Company
3-11 MORRELL ST.
ELIZABETH 4, NEW JERSEY
"The Original Marking Specialists"

put and a means to measure output current. It permits calculation of d-c. resistance based on test voltage and output current flow. Ammeter protected against damage by output short circuit. A-c. ripple within 1 percent. Range: 0-5000 volts d.c.; 0-5-10-50 and 100 microamps. Special models can be furnished to 7500 volts and 5 microamps to 2 milliamps. Output terminates in a retractable-tip high-voltage prod and rubber-covered ground clip.—*Associated Research, Inc., 3766 W. Belmont Ave., Chicago 18, Ill.*

Mention No. 1477 when filling out card.

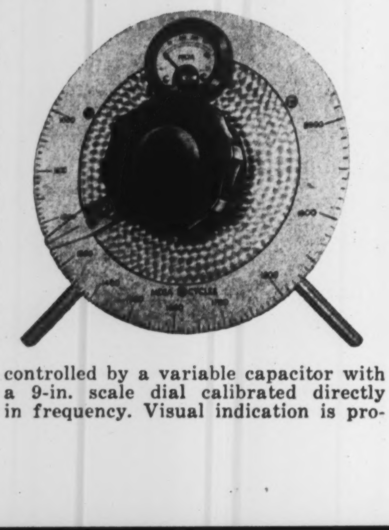
Mechanical Band-pass Filter

New "Mechanical Filter" is a permanently-tuned band-pass filter for i-f. amplifier applications. Magnetostrictive elements of filter provide selectivity characteristics approximating ideal rectangular shape needed for close spacing of adjacent voice communication channels. Space requirements are minimal (see illustration); hermetically-sealed unit requires no adjustment. Operating frequency 455 kc., nominal bandwidth 3 kc., input and output impedance 6,500 ohms.—*Collins Radio Co., Cedar Rapids, Iowa.*

Mention No. 1478 when filling out card.

UHF Frequency Meters

New series of absorption-type frequency meters cover spectrum from 125 to 4000 Mc. Instrument consists essentially of a tuned concentric line controlled by a variable capacitor with a 9-in. scale dial calibrated directly in frequency. Visual indication is provided by a 250-ua. microammeter. Type "N" fitting equipped with probe antenna permits measurement of transmitter frequency either through radiation or directly coupled via coaxial connector. Capable of measuring either a pulse or sine wave, instrument provides accuracies to 0.1 percent.—*Marconi Instruments Ltd., 23 Beaver St., New York 4, N. Y.*



Mention No. 1479 when filling out card.

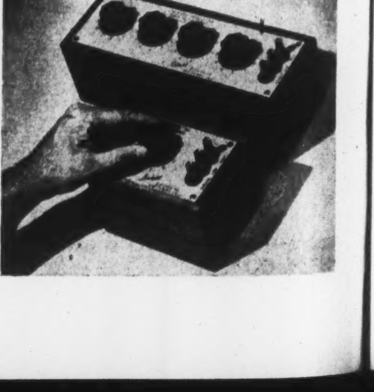
Phase-angle Standard

New "Type 7000-A Primary Phase Standard," custom-designed for any fixed frequency between 20 cps. and 20 kc. selected by purchaser, provides two voltages of same frequency whose phase angle is continuously variable from 0 to 360 degrees and is indicated by multiple Lissajous patterns. Accuracy 0.05 degree (better than 0.01 degree by special operating techniques). Output level 0-10 volts from low-impedance cathode followers.—*Technology Instrument Corp., Acton, Mass.*

Mention No. 1480 when filling out card.

Decade Inductors

New "Type DE" decade inductors are available with inductance values guaranteed to within one percent. Four units cover ranges 1-10 mH, 10-100 mH, 100 mH-1 H, and 1-10 H; are also available as a single unit to cover complete range from 1 mH to 10 H.



Special ranges available on request. Moisture-resistant impregnated inductors are wound on molybdenum-permalloy toroidal cores for high-Q and low external pickup. Each decade has complete electrostatic shielding.—*Lenkurt Electric Co.,* 1118 *County Road, San Carlos, Calif.*

Mention No. 1481 when filling out card.

Resistance and Leakage Tester

New "Model C-3" combined ohmmeter and leakage tester, for production testing of transformers, etc., has a useful range of 1 ohm to 1 million megohms.

Four ohmmeter ranges are powered by a 1.5-v. battery; six megohm ranges apply a maximum of 105 v. to unit under test. Accuracy is plus or minus 3 percent of full-scale deflection for all ranges except highest megohms range which is plus or minus 5 percent.—*Southwestern Industrial Electronics Co., Houston* 19, *Texas.*

Mention No. 1482 when filling out card.

Motor Control

New "C-25" operates 1/50th to 1/4 hp. shunt-wound d-c. motors, wound for 115 v. dc., on 110-120 v. ac.; consists of a half-wave thyratron rectifier circuit operating on one C3J tube to feed armature and a selenium rectifier stack to operate field circuit. Armature voltage can be varied from 20 to 130 volts. From 20 to 60 volts, when armature is loaded, voltage automatic-

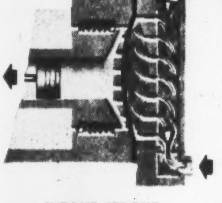
POWER
OFF
ON
ADJUST SPEED
C-25 MOTOR CONTROL
G.K.HELLER CO. BALTIMORE 30,MD.
FORWARD
OFF

NO STUFFING BOX

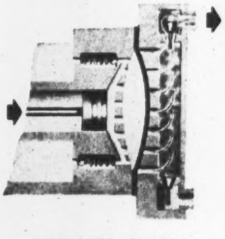
Lapp

Auto-Pneumatic

PULSAFEEDER



INTAKE STROKE



DISCHARGE STROKE

No packing or other leak-likely gland can be in contact with chemical being handled by the Lapp Pulsafeeder. A hydraulically-balanced diaphragm acts as a floating partition, without mechanical load or pressure differential—assures isolation of chemicals being pumped from all working pump parts Pumps against pressures to 2,000 lbs., at constant pumping speed—variable flow for continuous processing results from variation in piston-stroke length-controlled by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR NEW BULLETIN No. 300, just issued. 24 pages of description, specifications, typical applications, flow charts. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Division 573 Maple Street, Le Roy, N. Y.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 42 years.

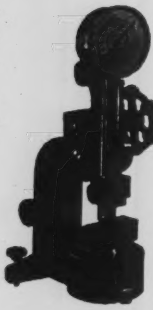
In general use for specification purposes. Simple, sturdy. Comparatively inexpensive

•

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway
Jamaica 2, N. Y.



High Precision OPTICAL COMPONENTS Any Size For Astronomical and Physical Research

•

Parabolic, Spherical, Ellipsoidal and Plane MIRRORS

•

Plane Parallel PLATES

•

SCHLIEREN SYSTEMS

•

Wind Tunnel OPTICS

•

LENSES & PRISMS of Glass Natural or Synthetic CRYSTALS

•

Complete Optical and Mechanical INSTRUMENTS

•

Made to Specifications

•

High Vacuum Coating

•

John Unertl Optical Co.

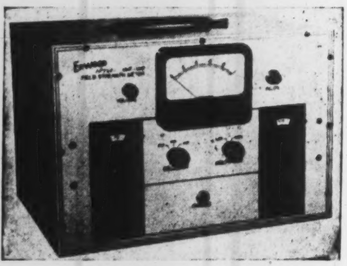
3551-3555 East Street
Pittsburgh 14, Penna.

ally increases to take care of loading. Above 60 volts, voltage remains steady. Field voltage remains constant over entire range of about 50 to 2400 rpm. Motor can be reversed, and a dynamic brake is also included in circuit. Speed control is stepless. Circuit is protected with a time delay relay until filament of C3J has attained operating temperature—*Gerald K. Heller Co.*, 1540 *Ridgely St., Baltimore* 30, *Md.*

Mention No. 1483 when filling out card.

Field Strength Meter

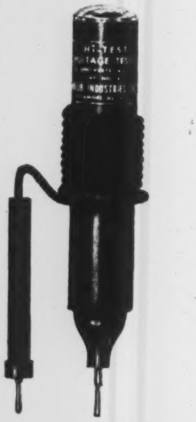
New UHF-VHF field strength meter covers all frequencies used today in broadcasting TV and FM programs; is also useful in determining relative efficiency of different types of antennas as well as optimum height. VHF range is continuous from 52 to 218 Mc. with sensitivity at 60 percent deflection per 100 mv. input. UHF range is continuous from 470 to 890 Mc. with sensitivity at 50 percent deflection per 100 mv. input. —*Erwood, Inc.*, 1770 *Berteau St., Chicago* 13, *Ill.*



Mention No. 1484 when filling out card.

Voltage Tester

New "Hi-Test" voltage tester having only one test lead indicates from 115 to 600 volts a.c. or d.c. Second test prod is permanently mounted in one end of tester; voltage scale, located in opposite end where it is always in full view, is a drum type scale, covered and protected with a magnifying lens. Flashover between ends of solenoid coil is eliminated in new design, as wires are brought out of case at opposite ends of coil.—*Holub Industries, Inc.*, 413 *DeKalb Ave., Sycamore, Illinois.*



Mention No. 1485 when filling out card.

Miniature Pulse Transformer

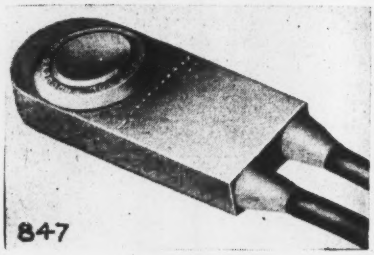
New "MPT 101-0.1," said to be the world's smallest pulse transformer, is designed for low-power blocking oscillator and other pulse-circuit applications; produces a pulse width of 0.1 microsecond when used in standard PCA circuit. Use of a special impregnant and embedment resin provides sufficient moisture and shock resistance to pass MIL-T-27 specs. Units are individually tested to insure uniform quality and dependability.—*PCA Inc.*, 6368 *De Longpre Ave., Hollywood* 28, *Calif.*

Actual size
PCA
730

Mention No. 1486 when filling out card.

Snap-action Waterproof Switch

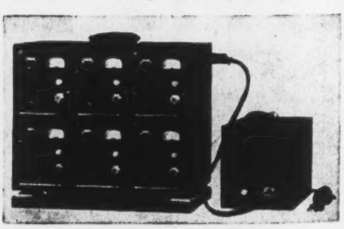
New sine curve waterproof switch is for use where extreme environmental conditions are encountered. Basic mechanism is a radically new type of overcenter snap-action motion formed by means of a flat strip of beryllium copper punched into shape of sine curve. Silicone cover completely seals switch from moisture and dirt as well as making it explosion-proof and waterproof. Can be made in many styles. Rated at 20 amps. at 28 v. d.c.—*Control Products, Inc., Harrison, N. J.*



Mention No. 1487 when filling out card.

Six-amplifier System

New "Model 201-A Six-channel Amplifier Unit" is a portable (69-lb.) self-contained system for accurate measurement of strain, pressure, acceleration, vibratory displacement, and velocity. Consists of six individually-excited 3-stage single-channel amplifiers with output metering and overload indicating circuits and with linear and integrated amplification; a separate regulated a-c. and d-c. power supply; a shock-mounted cabinet with power plugs for inserting amplifier units; and power and test cable assemblies.—*Yellow Springs Instrument Co., Yellow Springs, Ohio.*



Mention No. 1488 when filling out card.

Plug-in Octal Transformers

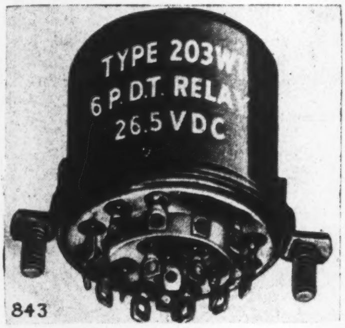
New "PO" (plug-in octal) series of pulse transformers pass MIL-T-27 specs; are intended for use in blocking oscillator and other pulse circuits; have identical electrical characteristics to "MPT" series; are available with pulse widths from 0.1 to 16 microseconds when used in standard PCA circuit.—*PCA Inc., 6368 De Longpre Ave., Hollywood 28, Calif.*

Actual size
PCA
PO-111-4
731

Mention No. 1489 when filling out card.

Miniaturized D-c. Relay

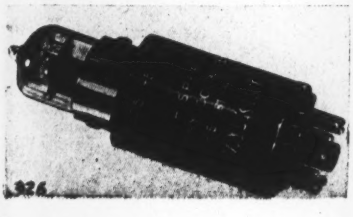
New "203W1" miniaturized d-c. relay designed for general use throughout electrical systems of military aircraft is of 6-p. d-t. type operating on 26.5 volts; has palladium contacts and moisture-free-gas filling; is designed to meet MIL-R-5757 and is engineered to provide long service under extremes of temperature, humidity, shock, vibration, and voltage variations; weighs 3 oz.; can be operated in any position.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*



Mention No. 1490 when filling out card.

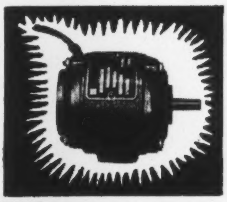
Binary Counter

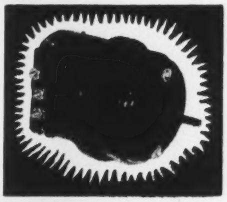
New "Type M1552" high-speed binary counter for all types of counting and frequency division to rates in exces of 3 Mc. is sealed and ruggedized; has an 11-prong octal-type base plug which allows access to tube elements

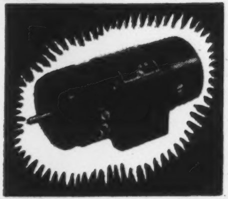


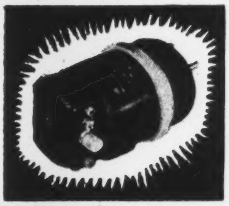
WHEN YOU THINK OF *Instruments* THINK OF ELINCO

SUB-FRACTIONAL MOTORS AND GENERATORS


BS FRAME


F FRAME


CB FRAME


FB FRAME

SERVICES
1-, 2-, 3-, & 5-speed Synchronous
AC Dynamically Braked
Adjustable speed
Governor-Controlled
Self-Starting
Reversible

This time, try Elinco on that "special" problem of instrumentation. With hundreds of variations on over 600 basic models already manufactured, you may find that your special problem has been "pre-engineered" in the design files at Elinco. In tachometers, for instance, Elinco has developed countless high-precision variations of:

AC TACHOMETERS	DC TACHOMETERS
2-4-6-12 Poles	0.9 to 10 Volts at 100 r.p.m.
1-2-3 Phase	Voltage Output Linear
Standard Units	With Speed Within
Sine Wave Units	1% in Either Direction

FEATURES

Instrument-type precision ball bearings.
Every unit balanced dynamically . . . and *individually tested* under *specific load conditions.*
Ultra-precision manufacture of *all* parts.

PLUS

ANY physical or electrical variation to meet your specific requirements.
OVER 600 basic models with hundreds of variations already manufactured.

TYPES

AC • DC • Universal
Servo • Self-synchronous

RATINGS 1/3000 to 1/6 H P

PHASES One-, two-, and three-phase

WINDINGS

Compound • Shunt • Series
Separately Excited • Split Field
Permanent Magnet • Reluctance
Hysteresis • Stabilized Hysteresis
Induction • Drag Cup

PLEASE

. . . outline your problem in *full* detail when requesting quotations or literature. We have NO STOCK UNITS, no "mass-produced" units available. Every ELINCO unit is a precision instrument, specially designed and manufactured to meet your highest specific performance standards.

ELINCO

ELECTRIC INDICATOR CO.

CAMP AVENUE • SPRINGDALE • CONN.

RELIABLY ACCURATE UNDER PLANT CONDITIONS

continuous process-stream analysis

for

- trace monitoring
- separation control
- composition cost accounting
- synthesis control
- stream blending

Plant stream analysis by continuous infrared-absorption methods has proved itself to be a decisive factor in the success and efficiency of processes involving chemical, petro-chemical, and petroleum-derived streams.

The Baird Associates Plant Stream Analyzer has proved itself to be the instrument for the job: with high sensitivity, rapid response, rock-solid stability, explosion-proof design, complete reliability under the most rugged conditions, and adaptability to an unlimited range of applications.

Where are its potential uses? In any process industry where the concentration of an infrared-absorbing component in a process stream is a critical index of operation. All organic substances, and many inorganic ones, are infrared-absorbers.

What are its present, tested applications? We hold details of all applications in confidence, for our clients. But when we know your problem, we can tell you how to satisfy yourself about our claims before going further.

We are staffed to understand your problem in your own terms — quickly and competently. Write us today.

PROCESS CONTROLS

a division of Baird Associates, Inc.

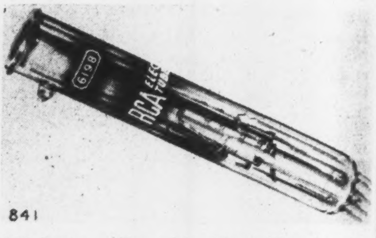
11 UNIVERSITY ROAD CAMBRIDGE 38, MASSACHUSETTS

and other important circuit points. Input: 75 volt negative pulses with a rise time of 0.2 microseconds. Output: 125 volts, with a rise time of 0.2 microseconds. Tube type: 5670 or 2C51. Power: 17 ma. at 250v. Unit operates over an ambient temperature range of -40 C. to 70 C.—*The Walkirt Co., Inglewood, Calif.*

Mention No. 1491 when filling out card.

Industrial TV Camera Tube

New "6198 Vidicon" is a small (6-in.) TV camera tube intended for industrial television applications. Its sensitivity permits televising scenes with 100 to 200 foot-candles of incident illumination on scene. Photoconductive layer has a spectral response approaching that of human eye. Tube provides 400-line resolution; employs magnetic focus and magnetic deflection; operates with relatively low dc. voltages.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

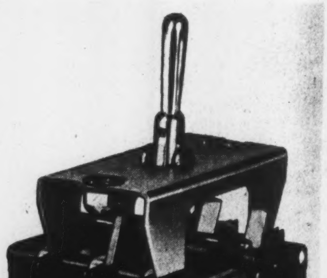


841

Mention No. 1492 when filling out card.

Toggle-switch Assemblies

New precision toggle switch assemblies of a new type for multiple circuit control, are available with one to ten double-throw switching elements operated by a single lever. Lever may be detented in center and either or both extreme positions, or may be self-returning to center. Each switching element is UL listed at 10 amps. 250 v.ac. and will handle 30 v.dc. inductive loads of 10 amps. at sea level and 6 amps. at 50,000-foot altitudes.—*Micro Switch, Freeport, Illinois.*



Mention No. 1493 when filling out card.

VHF Triode Pentode

New "6X8" miniature 9-pin medium-mu triode and sharp cutoff pentode is designed as a combined mixer and oscillator in receivers using an i.f. of ap-

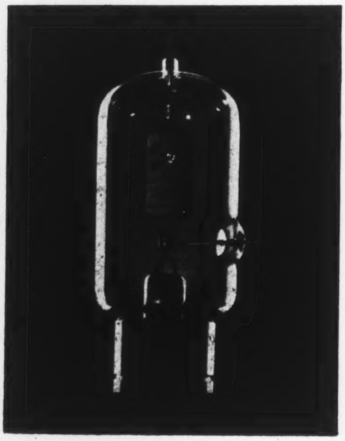
6X8
SYLVANIA
MADE IN USA
840

prox. 40 Mc. Pentode section characteristics are similar to "6AG5," triode section to one section of "6J6." Except for a common cathode, application of "6X8" is similar to "6U8." Pentode mixer section provides low grid No. 1 to plate capacitance as compared with a triode mixer, minimizing mixer feedback problems.—*Radio Tube Div., Sylvania Electric Products Inc.,* 1740 *Broadway, New York* 19, *N. Y.*

Mention No. 1494 when filling out card.

Medium-mu Triode

New "Los Gatos brand Type 254" medium-mu triode has thoriated tungsten filament. Voltage 5.0; current 7.5 amps.; plate dissipation 100 watts;



max. ave. plate current 225 ma.; max. ave. grid current 60 ma.: max. plate voltage 4000; ave. amplif. constant 25.—*Lewis and Kaufman, Inc.,* 110 *El Rancho Ave., Los Gatos, Calif.*

Mention No. 1495 when filling out card.

Multi-unit Miniature Tube

New "12BF6" multi-unit miniature tube of heater-cathode type containing two diodes and a medium-mu triode, for use as a combined detector, amplifier,

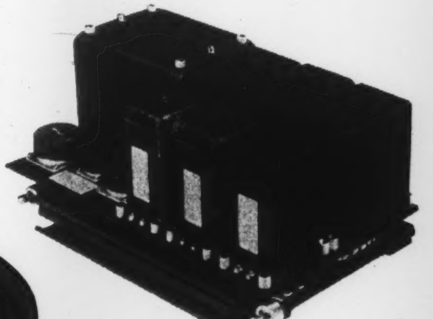
12BF6
RCA ELECTRON TUBE
839

Now—
advanced electronic
instrumentation

...simplified by "building block" electronic packages makes possible synthesis of present and future aircraft control systems.

Servomechanisms, Inc., has pioneered in developing functionally-packaged standard plug-in units for electronic and electromechanical aircraft instrumentation. Servomechanisms technique of MECHATRONICS...the multiple and interchangeable use of standard units achieves simplified control systems which solve the aircraft need for:

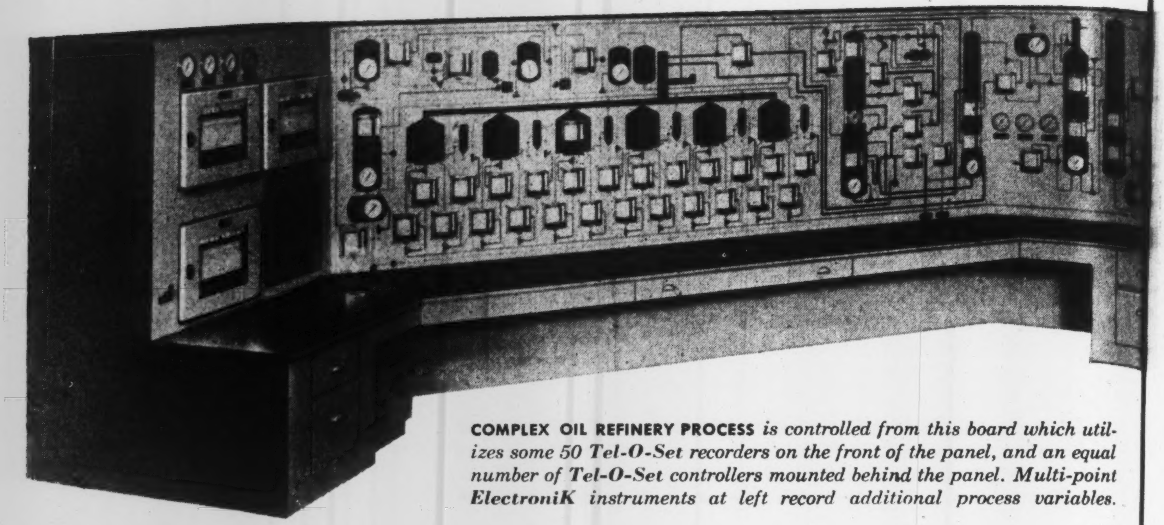
- **Instant Maintainability**
- **Spatial Adaptability**
- **Training Simplicity**
- **Ease of Assembly**



A typical Servomechanisms, Inc. control system showing the multiple combination of building blocks, each block easily removable and replaceable...simple to check and service.

mecha

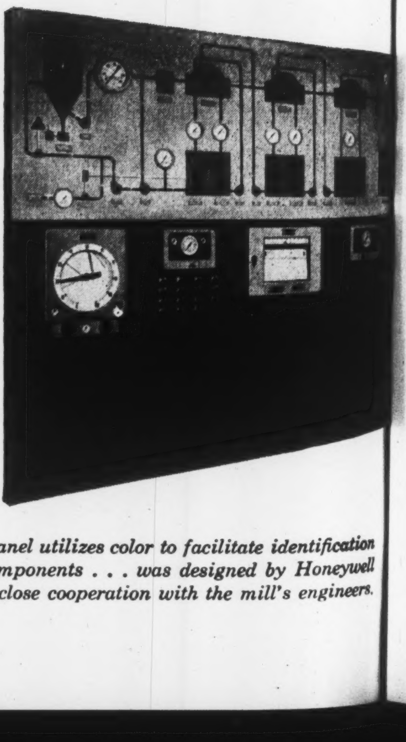
POST & STEWART AVENUES, WESTBURY, N.Y.



COMPLEX OIL REFINERY PROCESS *is controlled from this board which utilizes some 50 Tel-O-Set recorders on the front of the panel, and an equal number of Tel-O-Set controllers mounted behind the panel. Multi-point ElectroniK instruments at left record additional process variables.*

Graphic Panels for Centralized Instrumentation

CHEMICAL PLANT *panel combines the graphic theme with conventional size controlling instruments. It is built as a vapor-tight cubicle with a console front and overhanging light canopy.*



PAPER MILL *panel utilizes color to facilitate identification of process components . . . was designed by Honeywell engineers in close cooperation with the mill's engineers.*

PANEL PRODUCTION *in Honeywell's extensive shop devoted exclusively to panel work—utilizes the skills of highly trained specialists. All instruments, controllers, accessories, and back of panel wiring, and piping are carefully assembled—then subjected to rigorous tests to assure trouble-free installation and start-up when the panel reaches your plant.*

n. . . *a progress report from Honeywell*

SHOWN here are just a few of the many graphic instrument panels which Honeywell has supplied for centralized control of a wide variety of industrial processes. Each one is the result of well-seasoned engineering know-how . . . based on extensive Honeywell experience . . . which combines all instruments and accessories into a closely integrated, efficient design.

Whether your process calls for a full graphic or semi-graphic panel . . . a conventional board . . . or a control cubicle . . . you can be sure of obtaining every feature of quality and performance that you need in a Honeywell panel.

In Honeywell's Panel Division, meticulous attention to engineering detail and highly developed construction techniques watch over every step—from blueprint to assembly to final test. Add to this engineering and manufacturing skill the availability of a complete line of conventional and miniature instruments, and the result is a control board . . . custom-fitted to *your* needs . . . that makes *Panels by Honeywell* synonymous with the best in centralized control.

Our local engineering representative will be glad to discuss how graphic panels by Honeywell can bring new efficiency to your processes. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Penna.

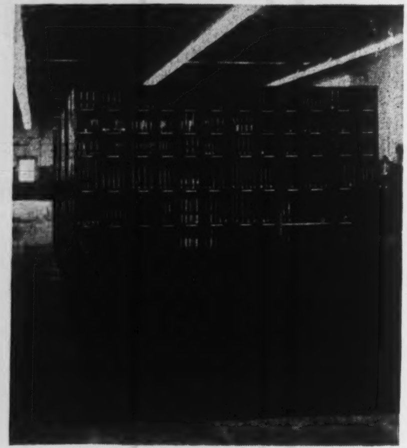
MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

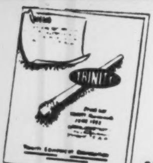
H
HONEYWELL

● *Important Reference Data*

Write for your copy of Bulletin No. 85-20, "Centralized Instrumentation . . . unlimited."

from Stock
TRINITY
THERMOWELLS





AVAILABLE

NOW!

from Stock

TRINITY THERMOWELLS

—in a wide variety of designs, sizes and materials.

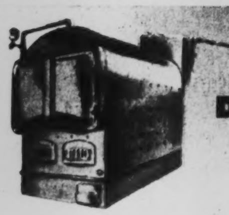
We will be glad to place your name on the list to receive copies of the monthly Trinity Thermowell Stock List.

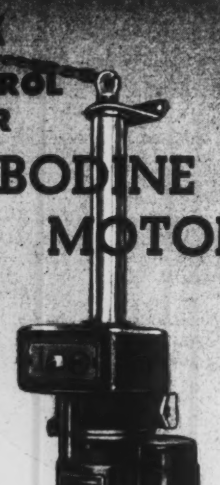
Request your copy now.

2106

TRINITY EQUIPMENT CORPORATION 494 Westfield Ave., East Roselle Park, New Jersey

THERMOWELLS and other Specialties for the Process Industries





PERFEX DRAFT CONTROL ACTUATOR USES A BODINE MOTOR

A lot of money, in the form of heat, can escape up a chimney. The Perfex Draft Control eliminates this waste by providing the fire with the right amount of oxygen while the furnace is on, and bottles the heat in the furnace during off periods. This results in a saving of fuel, reduction of chimney smoke and soot, and lengthens the life of the boiler. A Bodine motor positions the uptake damper to maintain the correct overfire draft condition.

"During the course of the design of this actuator," relates the Perfex Corporation, "we set up very rigid specifications and requirements for a motor which would properly power our device. These specifications were submitted to various motor manufacturers of good reputation for design purposes. Your organization was able to supply us with a very satisfactory design at an attractive price and was selected for this reason. We appreciate the good attention your company has given us at all times and are well pleased with the quality of the motor."

If you have a fractional horsepower motor application problem, it will pay you to consult Bodine engineers.

OUR REPRESENTATIVES THOMAS REGISTER

BODINE Fractional Hp Electric MOTORS

Bodine Electric Co., 2244 W. Ohio St., Chicago 12, Ill.

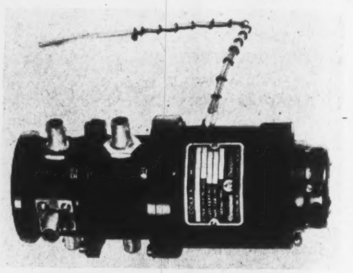
THE POWER BEHIND THE LEADING PRODUCTS

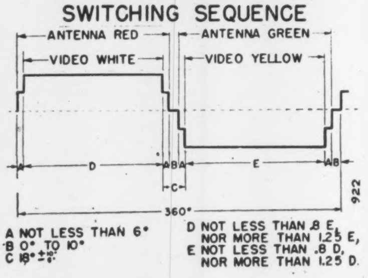
and a-v-c. tube in receivers operating from 12-v. battery; can be impedance-coupled or transformer-coupled to output stage; can supply ample output to drive a pair of 12V6-GT's in output stage of receivers.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

Mention No. 1496 when filling out card.

Motor-operated R-f. Switch

New "Model CA-31 Sensing Switch" is double-pole double-throw switch comprising r-f. head and 115-v. motor for actuating head. Two independent r-f. circuits are switched at a rapid rate (15 to 34 cps.) to accomplish accurate circuit time-sharing. Frequency range is 0 to 250 Mc.—*Electronics Div., Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland 3, Ohio.*

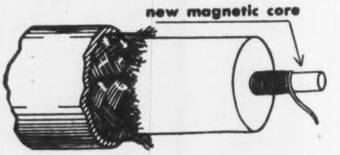




Mention No. 1497 when filling out card.

High-impedance Delay Cable with Magnetic Core

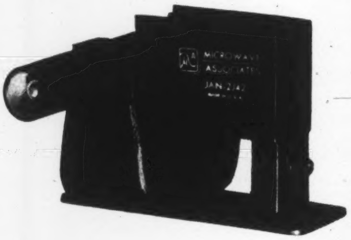
New "Type HH-1500 Delay Cable" is said to represent a radical departure from conventional design of delay line with distributed parameters: features a flexible low-loss magnetic core of uniform structure which nearly triples inductance of cable assembly, thereby effectively increasing its characteristic impedance as well as time delay while substantially maintaining dimensions and attenuation characteristic of conventional high-impedance cables. Delay per foot is 0.073 usec. as compared to 0.042 of commonly-used RG-65/U cable. Hence a saving of about 40 percent in



cable length and considerably greater signal amplitude and fidelity since attenuation level (db/ft) is similar to that of RG-65/U. Minimum bending radius is 2 in.—*Columbia Technical Corp.*, 5 *East 57th St., New York* 22, *N. Y.*
Mention No. 1498 when filling out card.

Magnetrons

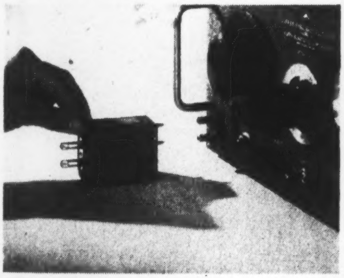
New "Type 2J42 and 2J42A (6027)" magnetrons are 3-cm. magnetrons. "Type 2J42" is low-powered (17-watt average) packaged magnetron, with



coaxial-to-waveguide output stabilized by a cavity integral to assembly. "Type 2J42A (6027)" is physically similar but is supplied with additional magnet permitting average power of 21 watts. —*Microwave Associates, Inc., Boston* 15, *Mass.*
Mention No. 1499 when filling out card.

Line-bridging Transformer

New "Model 122" line-bridging transformer converts unbalanced input to balanced input and is arranged for direct plug-in attachment to measuring

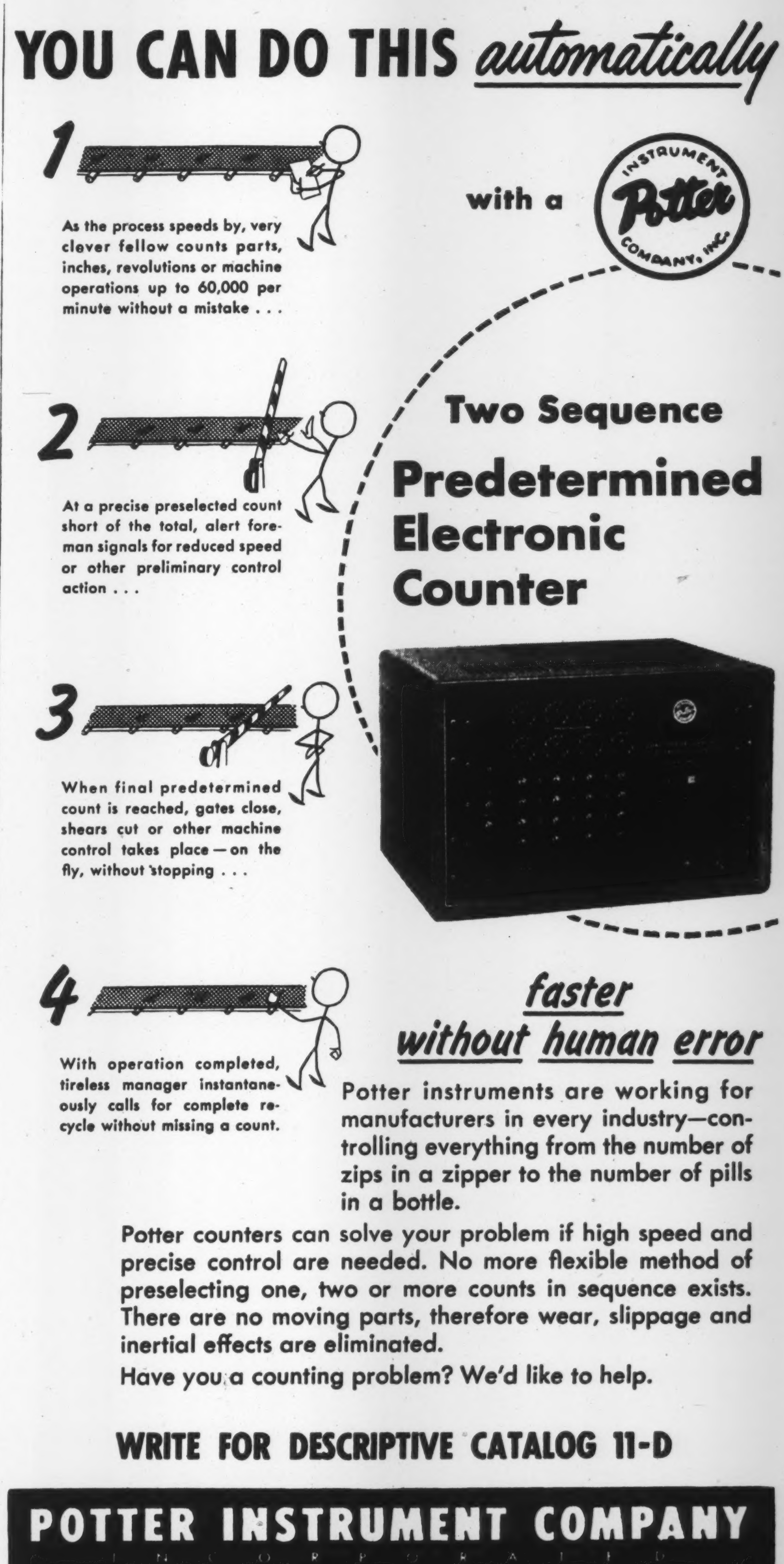


instruments. Flat within 0.5 db. from 15 to 500 kc., new unit can handle max. voltage of 100 v. Input impedances of 135, 500, and 600 ohms are available. —*Sierra Electronic Corp.*, 831 *Brittan Ave., San Carlos, Calif.*
Mention No. 1500 when filling out card.

Cold-cathode Triode

New "Haledy TT-1" cold-cathode triode tube of unlimited life is applicable

HALEDY
COLD CATHODE
MODEL TT-1
836


YOU CAN DO THIS *automatically*

with a Potter Instrument Company, Inc.

1 As the process speeds by, very clever fellow counts parts, inches, revolutions or machine operations up to 60,000 per minute without a mistake . . .

2 At a precise preselected count short of the total, alert foreman signals for reduced speed or other preliminary control action . . .

3 When final predetermined count is reached, gates close, shears cut or other machine control takes place—on the fly, without stopping . . .

4 With operation completed, tireless manager instantaneously calls for complete recycle without missing a count.

Two Sequence
Predetermined Electronic Counter

faster without human error

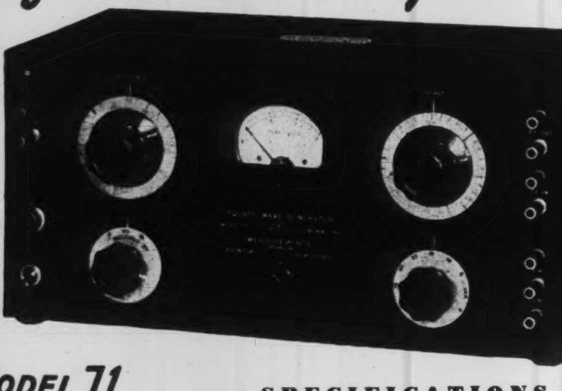
Potter instruments are working for manufacturers in every industry—controlling everything from the number of zips in a zipper to the number of pills in a bottle.

Potter counters can solve your problem if high speed and precise control are needed. No more flexible method of preselecting one, two or more counts in sequence exists. There are no moving parts, therefore wear, slippage and inertial effects are eliminated.
Have you a counting problem? We'd like to help.

WRITE FOR DESCRIPTIVE CATALOG 11-D

POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

Square Wave Generator



MODEL 71

SPECIFICATIONS

FREQUENCY RANGE: 5 to 100,000 cycles.

WAVE SHAPE: Rise time less than 0.2 microseconds with negligible overshoot.

OUTPUT VOLTAGE: Step attenuator giving 75, 50, 25, 15, 10, 5 peak volts fixed and 0 to 2.5 volts continuously variable.

SYNCHRONIZING OUTPUT: 25 volts peak.

R. F. MODULATOR: 5 volts maximum carrier input. Translation gain is approximately unity—Output impedance is 600 ohms.

POWER SUPPLY: 117 volts, 50-60 cycles.

DIMENSIONS: 7" high x 15" wide x 7½" deep, overall.

MANUFACTURERS OF
Standard Signal Generators
Pulse Generators
FM Signal Generators
Square Wave Generators
Vacuum Tube Voltmeters
UHF Radio Noise & Field Strength Meters
L-C-R Bridges
Megohm Meters
Megacycle Meters
Intermodulation Meters
TV & FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

Abrasion Resistance TEST
for Metals, Ceramics, Rubber, Plastics & Textiles

Be 100% right in all your wear and abrasion tests with the Taber Abraser. This instrument simulates *actual wear conditions* on metals, plastics, paints, rubber, linoleum and textiles during test and gives you an accurate numerical index for your report. Recognized as the standard abrasion test and used by leading product research laboratories the world over.

Send for FREE FOLDER

Taber INSTRUMENT CORPORATION
111 ST Goundry St., North Tonawanda, N. Y.

ALSO WRITE FOR FREE LITERATURE ON
★ V-5 Stiffness Gauge ★ Scratch and Toughness Testers For Plastics

as control for all types of industrial electronic equipment. Contains external electrode; can operate under any temperature conditions; eliminates warm-up time. Circuits employing tube yield amplification of 2.5 million or more, and a grid current of less than 1 ua.—*Haledy Electronics Co., 57 William St., New York, N. Y.*

Mention No. 1501 when filling out card.

Half-wave Vacuum Rectifier

New "6AX4-GT" is half-wave vacuum rectifier tube of heater-cathode type, for use as a damper tube in horizontal-deflection circuits of TV receivers. Withstands negative peak pulses between heater and cathode of 4000 volts.—*Tube Dep't, Radio Corporation of America, Harrison, N. J.*

6AX4-GT
RCA
ELECTRON TUBE

Mention No. 1502 when filling out card.

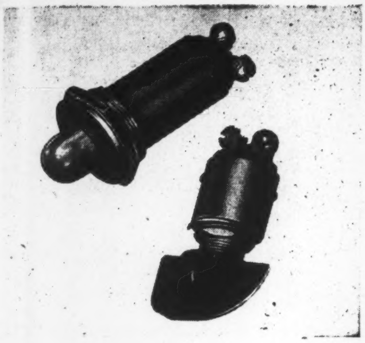
Antenna Selector

New "Cat. No. 873" low-loss triple-circuit antenna selector is designed for selection at receiver of signals from any one of three antennas. Length of 300-ohm line is attached to common side of selector; screw-terminals provided for connections to three selector points.—*Technical Appliance Corp., Sherburne, N. Y.*

Mention No. 1503 when filling out card.

Push-push and Rotary Switches

New "Type J100 push on - push off" switch has contactor design said to assure positive contact even under adverse operating conditions. Contact sur-

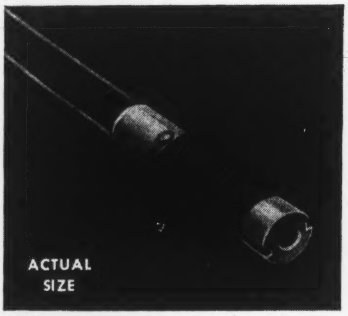


faces are heavily silvered. Operates at either 28 v. d.c. or 115 v. a.c., 60 cycles; rated at 20 amp. resistive. New "Type R1000" is similar but designed for rotary action with an indicator knob. *—Hetherington, Inc., Sharon Hill, Pa.*

Mention No. 1504 when filling out card.

Instrument Resistor

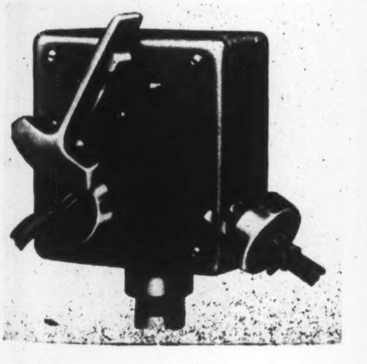
New "Type 245S" 1-watt precision wire-wound resistor, for decades and other applications requiring low resistance values with low temperature rise and low inductance, can be calibrated to a tolerance of 1 percent or better; is available in values from 0.1 ohm to 1000 ohms.—*Shallcross Mfg. Co., Collingdale, Penna.*

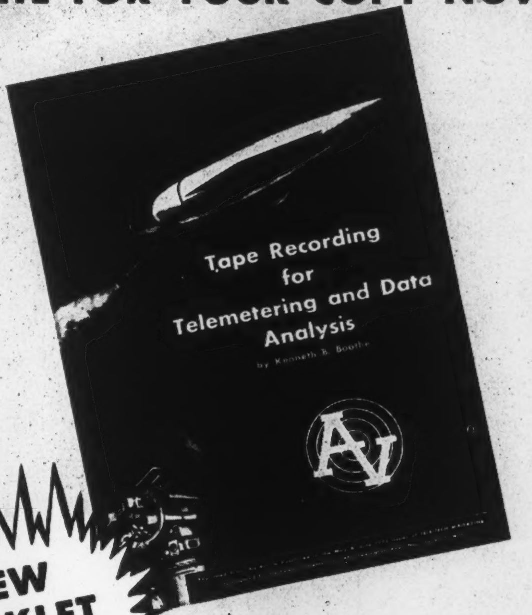


Mention No. 1505 when filling out card.

Interlock Receptacle

New interlocking receptacle permits use of cord sets for hazardous locations. It incorporates a sealed mercury switch which de-energizes each socket before a plug may be inserted or removed, eliminating all danger of spark-




Tape Recording for Telemetering and Data Analysis
by Kenneth B. Boothe
AV

just off the press!

WRITE FOR YOUR COPY NOW...

A NEW BOOKLET

AMPEX

SPECIAL PURPOSE MAGNETIC TAPE RECORDERS

...described in detail in this new booklet published by the...

Instrumentation Division
of the
Audio & Video
PRODUCTS CORPORATION
730 Fifth Avenue New York 19, N. Y.
Plaza 7-3091

(use this coupon for convenience)

AUDIO & VIDEO PRODUCTS CORPORATION Dept. I-11
Instrumentation Division
730 Fifth Avenue
New York 19, New York

Please send me a copy of your booklet
"Tape Recording for Telemetering and Data Analysis"

Name .... Title ....

Company ....

Address ....

force measuring system

uses

HEISE GAUGES

for
- EXTREME ACCURACY
- STABILITY
- SERVICE

The Emery Hydraulic Weighing System measures forces in materials testing machines, in testing jet engine thrust and dynamometer torque, and in other special force problems. In these exacting applications, Heise Bourdon Gauges indicate loads to an accuracy of 1/10 of 1% of capacity.

Heise Gauges are used in many industries for precise measurements of pressure. Custom-built in pressure ranges from 0-15 to 0-10,000 psi. Sizes: 8½", 12", and 16" diameter. Prices from $151.60 to $211.20. Write for catalog.

Heise Bourdon Tube Company, Inc.
Newtown, Connecticut

No more worries about...
FREQUENCY RESPONSE or
WRITING SPEED with the

HATHAWAY Type SC-16
OSCILLOGRAPH

The NEW and PHENOMENAL Hathaway Type SC-16 Oscillograph with 6 elements is *flat from 0 to 200,000 cycles per second*, and its traces have a *writing speed of 5 million inches per second*.

Fast transients and high-frequency phenomena can be accurately recorded.

Several types of continuous-drive record magazines are available for 6-inch sensitized paper and film, and for 35-mm film. Drum-type magazines, both small and large, are valuable for short high-speed records. 10-foot drum-type charts can be driven at 3000 RPM for a *chart speed of 6000 inches per second* when high resolution is needed.

Useful for strain recording to 100 Kilocycles.

Automatic Operation Initiate a transient with the oscillograph, or let the transient start the oscillograph.
Quick-Change Transmission for wide range of record speeds.
Precision Time Lines. **Z-Axis Modulation** for timing to 1/10 millisecond.
Quickly-Interchangeable Lens Stages for different record and trace widths.
Write for Bulletin 2G1-L and free copy of Hathaway Engineering News

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

ing. Mercury switch cam lever locks cord set caps in position after they are inserted. In locked position, mercury switch completes circuit. A flip upward of cam lever tilts switch, breaks circuit and allows cord caps to be pulled out safely. Ratings: 115v. 20 amp. or 250v. 10 amp. Interlock receptacle may be furnished for single 3-wire; duplex 3-wire; dual 3-wire; single 4-wire; or dual 4-wire service.—*Tigerman Engineering Co., 4382 N. Western Ave., Chicago, Ill.*

Mention No. 1506 when filling out card.

Static Eliminator

New 3-inch "Staticmaster," molded of static-free plastic, is designed to remove static electricity and thereby prevent clinging foreign matter. One sweep of "Staticmaster" simultaneously removes static, dust, and lint. Object neutralized remains free until recharged by friction, handling, or rubbing.—*Dep't 31, Nuclear Products Co., 10173 E. Rush St., El Monte, Calif.*

838

Mention No. 1507 when filling out card.

Comparator Gages

New line of electrical (non-electronic) comparator gages comprises standard and special-purpose models (some

196

for Metric system) all having four ranges. All utilize an electromagnetic method of magnifying spindle movement. Absence of electron tubes or mechanical linkages assures long instrument life, and electromagnetic principle which is utilized is said to afford stability. By flicking a switch, any range is selected. For example, "Model No. 10" affords full-scale ranges of plus-or-minus 20, 40, 200 and 400 millionths of an inch. In the 20-microinch range each indicator division has a value of 1 microinch; in the 400-microinch range each division has a value of 20 microinches, etc. Spindle pressure is instantly adjustable from 4 to 40 oz., by means of a knob and associated, calibrated dial. Gaging head swivels 360 degrees in both horizontal and vertical planes and can be removed for use in special-gaging or remote-indication setups.—*The DoALL Co., Des Plaines, Illinois.*

Mention No. 1508 when filling out card.

Stroboscopic Disk for 3-speed Phonographs

New "Model 18-D, Phonostrobe Disk," when used with "Labstrobe" or other 60-cycle stroboscopic light source, permits quick and accurate determination of the three standard phonograph turntable speeds: 78, 45 and 33 1/3 rpm.—*Berkshire Laboratories, 508 Beaver Pond Road, Lincoln, Mass.*

BERKSHIRE PHONOSTROBE DISK
FOR USE WITH BERKSHIRE LABSTROBE
MODEL 18D
BERKSHIRE LABORATORIES

Mention No. 1509 when filling out card.

Cylindrical Toggle Switch

New "T1000" aviation type (MIL-S-6745) miniature toggle switch reduces size approx. 25 percent by comparison with conventional rectangular switches. Features include exceptionally effective contact wipe; positive cam-roller snap action that makes it impossible to

When Time is Unimportant

Its control is anybody's job. But when it involves an intricate problem, the concern that may be depended upon to correctly solve it is the **A. W. Haydon Company**

Thoroughly experienced timing engineers assure prompt, accurate solutions to the most difficult of proposed applications.

WRITE FOR CATALOG

The A. W. HAYDON COMPANY
22P NORTH ELM STREET
WATERBURY 20, CONNECTICUT
Design and Manufacture of Electrical Timing Devices

Pneumatic Weight Transmitters

FOR LINEAR CONVERSION OF WEIGHT INTO POUNDS PER SQUARE INCH AIR PRESSURE

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

WRITE FOR CATALOG

JOHN R. MONSELL
Manufacturing Engineer
Pitman, N. J.

TEST CHAMBERS

HIGH & LOW
TEMPERATURES
CONTROLLED
HUMIDITY

- +200°F. to —150°F.
- 20% to 95% R.H.
- 1 cu. ft. to 75 cu. ft. cabinets

Walk-in Rooms
Temperature Baths

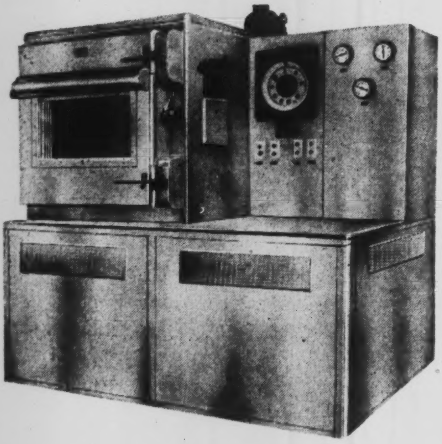
Electronic or pneumatic
recording or indicating
control systems

CUSTOM CHAMBERS
built to specifications.

Years of satisfactory service!

Standard
CABINET COMPANY

52 Washington Avenue
Carlstadt, New Jersey



PERMOPIVOTS of
PERMOMETAL*
*T. M. REG.

for
PRECISION
INSTRUMENTS

- LONG LIFE thru wear and vibration Resistance
- NON-ABRASIVE
- NON-MAGNETIC
- NON-CORROSIVE

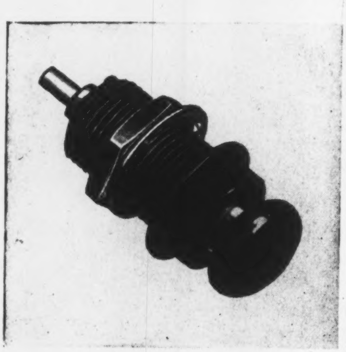
For an illustrated description of how PERMOPIVOTS are made, ask for the PERMOPIVOT booklet. For information on production of sub-miniature parts and assemblies, ask for the PERMO PRODUCTS booklet. Both free on request.

"tease" switch off contact; and strong lever operating action to break any contact welding that may result from an accidental overload. Switch is conservatively rated at 10 amps. Four circuit arrangements available: "on-off" and s.p.-d.t. maintained contact types and momentary on or momentary off and "on-momentary on" types.—*Hetherington, Inc., Sharon Hill, Pa.*

Mention No. 1510 when filling out card.

Indicator Light for Edge-lit Aircraft Panels

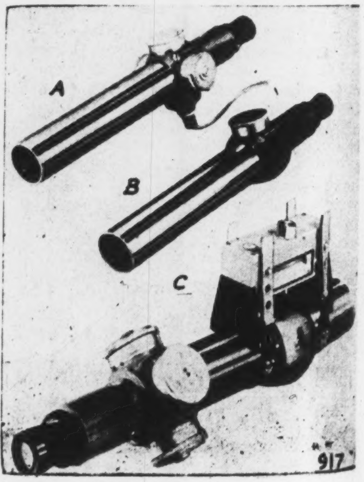
New "Type L2000" indicator light for edge-lit AN-P-89 aircraft panels flange-mounts on backup plate; socket extends through edge-lit panel; plastic lens screws into light socket from front of panel. Unit is 1.25 in. long over-all; weighs less than 0.25 oz.—*Hetherington, Inc., Sharon Hill, Penna.*



Mention No. 1511 when filling out card.

Optical Tooling Telescopes and Accessories

New "Micro Alignment Telescope" permits not only checking point alignment to 0.001-inch accuracy over distances from 18 inches to more than 150 feet, but also determining squareness of mirror targets through built-in auto-reflection. As a truly square



mirror target returns to operator an image of instrument's objective end, an out-of-square target will show this image out of center. Built-in illuminator and calibrated graticule permit operator to determine squareness of mirror target. (See Fig. A.) Where micrometer reading of displacement is not required, telescope is furnished in a simplified form (B) without built-in optical micrometers. This unit can also be equipped with auto-reflection. When necessary to set telescope truly horizontal, a stride-level (C) is provided which has precision split-bubble reading. For precise point and tilt alignment, an aligning tube (not illustrated) is furnished, consisting of a precision-ground chromium-plated barrel of same diameter as telescope, with two built-in targets at 10-inch distance. When both targets appear aligned in telescope, perfect alignment between telescope and aligning tube is established. New glass targets in 1.5-inch and 2.5-inch diameter to AIA standards provide permanent easily-cleaned reference points for alignment. Other accessories, such as collimators, mounting spheres, target rotators, optical squares, present a complete group of optical tooling devices.—*Engis Equipment Co.*, 431 *S. Dearborn St., Chicago* 5, *Ill.*

Mention No. 1512 when filling out card.

Multi-turn Slide-wire Potential Divider

New "Spiralpot" is designed for applications requiring high resolution with angular shaft displacement up to 3600 degrees, such as servo-control, computers, etc. Electrical output is exactly proportional to angular shaft position with brush traversing length of a resistance wire as shaft is rotated. Features include: unlimited (zero increment) resolution, extremely low noise level under all conditions, low torque, minimum inertia effect because of small mass of moving parts, positive mechanical stops that will hold up to 500 oz.-in. torque, close concentricity between shaft and mounting surface with a synchro-type mounting arrangement. Units are available in five standard resistance values from 500 to 2500 ohms in 500-ohm increments, will last over a million revolutions at 200 rpm.—*G. M. Giannini & Co., Pasadena* 1, *Cal.*

Mention No. 1513 when filling out card.

Toggle Switch

New "1SH1" hermetically-sealed precision toggle switch delivers its full electrical rating and operating charac-

Does your plant have a smoke or fume problem?

... THEN YOU NEED A

BENDIX-FRIEZ AEROVANE*

BENDIX FRIEZ

One of many Bendix-Friez precision instruments that are solving many important problems for industry.

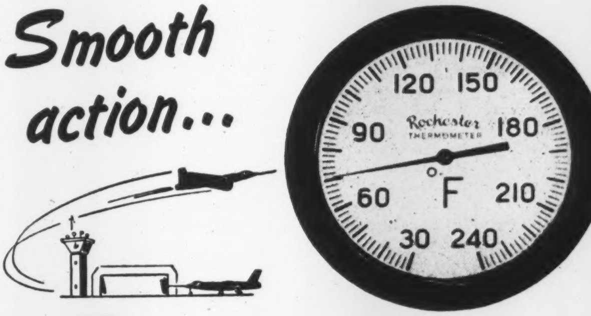
This finely-precisioned instrument provides a continuous, accurate, *electrically-written* record of wind direction and velocity. It offers you the *scientific* way to get data that's indispensable for working out smoke and fume control most effectively. Every day Bendix-Friez weather instruments . . . the accepted standard of comparison . . . are proving that they can perform more and more valuable services for industry. Let us demonstrate how we can help you.

*REG. U.S. PAT. OFF.

FRIEZ INSTRUMENT DIVISION of
1408 Taylor Avenue • Baltimore 4, Maryland
Export Sales:
Bendix International Division, 72 Fifth Avenue, New York 11, N.Y.

Bendix
AVIATION CORPORATION

Smooth action...



STAINLESS-STEEL CONSTRUCTION —welded—more durable, sensitive, pressure tight, corrosion resistant.

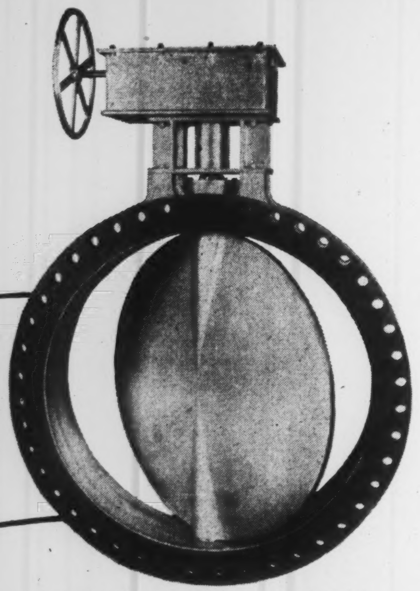
Rochester DIAL THERMOMETERS
react instantly to temperature changes!

• The superior dampening in ROCHESTER Dial Thermometers will never *"set-up"* or *"freeze"* the pointer in one position. It assures fast, smooth action at all times. New bimetallic elements never *"tire"* or lose their accuracy . . . take violent temperature change without error in indication.

Made of *corrosion resistant* stainless steel . . . backed by 35 years of instrument-making experience . . . ROCHESTER Dial Thermometers are ideal for heavy-duty service. *And they're made to meet U. S. Air Force specifications.*

Order them today from your Rochester Representative or write for further details. Rochester Manufacturing Co., Inc., 85 Rockwood St., Rochester 10, N. Y.

Rochester
Manufacturing Company, Inc.
85 Rockwood St., Rochester 10, N. Y.
ROCHESTER DEPENDABLE ACCURACY GAUGES
DIAL THERMOMETERS GAUGES AMMETERS



Get
Free Flow
Quick Control
Tight Shut-Off

W. S. ROCKWELL BUTTERFLY VALVES

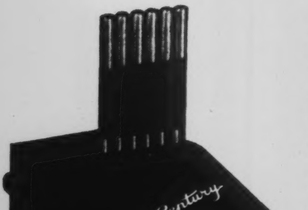
- ★ Minimum pressure drop—when fully open, valve practically as free as pipe itself.
- ★ Uniform, quick control manually or automatically.
- ★ Positive shutoff—commercial, drip tight or air tight.
- ★ Pressures to 600 p.s.i. Temperatures to 2000° F.
- ★ Made of any metal or rubber lined.
- ★ Sizes—1" to 72" and larger.

W. S. Rockwell 54" heavy duty butterfly valve; for 50 p.s.i.; with geared handwheel operator. May be equipped for electric, pneumatic or air operator control.

Get our Valve Catalog

W. S. ROCKWELL CO. • 2642 Eliot St., Fairfield, Conn.

Century MODEL 210 RECORDING GALVANOMETERS



COIL: Anodized aluminum wire. High space factor and low mass result in unprecedented efficiency.
SUSPENSION: Gold, silver or platinum ribbon, either flat or round depending on frequency.
STANDARD FREQUENCIES: 100, 200, 500, 850, 2000, 3300 cps.
DAMPING: Normally damped 64% of critical. Fluid or electro-magnetically damped depending on frequency.
MAGNETIC ASSEMBLY: Permanent Magnet type . . . Alnico V-DG. Assembly permits independent vertical and horizontal adjustment of each element with positive locking of adjustment.

SPECIFICATIONS:
Mirror: Cylindrical, focal lengths 11.5" or 6.2" are standard.
Size: 2.5" length; .125" diameter.
Weight: .11 oz.
Mounting: Plug in — no external wiring.
Pole Pieces: Integral with tubular case, except in fluid damped units.
Terminals: Within magnetic assembly. All elements are electrically isolated.
Balance: .010 per g at 15½".

Patented Century Nos. 2519591, 2519689, 2439576; Kannestine No. 2149442.

Write for Bulletin CGC-301

Century GEOPHYSICAL CORPORATION
TULSA, OKLAHOMA

4447 No. Bodine, Philadelphia 40, Pa. · 3406 W. Washington Blvd, Los Angeles 18, Calif. · 238 Lafayette St, Dayton 2, Ohio · 309 Browder St, Dallas, Texas · EXPORT OFFICE 149 Broadway, N. Y. City

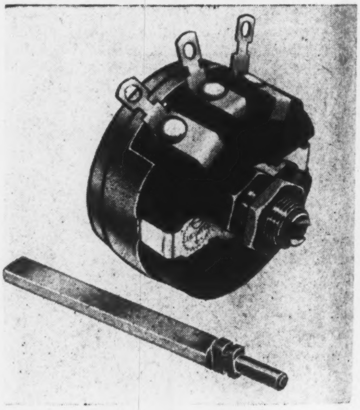
teristics without regard to changes in atmospheric pressure or temperature; is unaffected by corrosive atmosphere, dust, dirt, oil or water. Life expectancy far exceeds 25,000 operations. Basic switch is s-p.d-t. Tentative rating: 5 amps. motor load 30 v. d.c.; 25 amps. resistive load 30 v. d.c.; 1 amp. 125 v. a.c.—*Micro Switch Div., M-H, Freeport, Illinois.*

2 11/16
MICRO SWITCH
FREEPORT ILL. U.S.A.
CAT. NO.
944

Mention No. 1514 when filling out card.

Control Rheostats

New "Pick-A-Shaft" wire-wound controls with field-attached shafts come in three series: "A43" is maker's "43" rated at 2 watts; "A58" is maker's "58" rated at 3 watts; "A10" is maker's



Industrial Instrumentation Specialist

Successful, progressive chemical company offers challenging opportunities to specialist in the development and application of control instruments for chemical processes. The man we are seeking may be an engineering physicist, a physical chemist, or an electrical engineer. In addition to a B.S. or M.S. and approximately five years of industrial experience, he must have the ability not only to adapt instruments to new uses, but also to develop new instruments for new processes. If you believe you are this man, it will pay you to write at once giving complete details of education and experience. Your reply will be kept confidential.

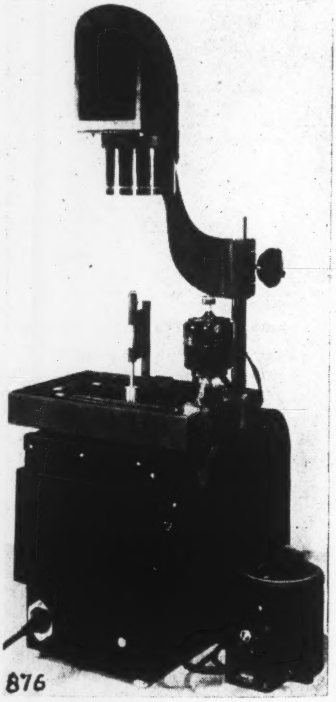
Rohm & Haas Company,
Office of Technical Employment
5000 Richmond Street,
Philadelphia 37, Pa.

"10" rated at 4 watts. Wide range of resistance values available in each series. Choice of any of eleven "Pick-A-Shafts" is made with purchase of unit. Procedure for attaching shaft is said to be fast, simple and sure.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

Mention No. 1515 when filling out card.

Fluid-mechanics Demonstrator

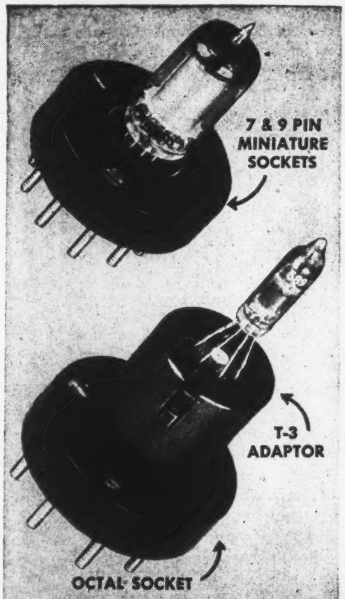
New "Double-return-flow Water-channel Demonstration Apparatus" featuring glass-bottom tank, variable-speed pump, 500-watt projector, etc., provides a vivid means of showing fundamental phenomena of flow of water through an open channel having either changes in cross section or obstructions in stream. Shock waves can be obtained and studies at different Mach members can be made.—*Ann Arbor Instrument Works, 725 Packard St., Ann Arbor, Mich.*



876

Mention No. 1516 when filling out card.

WANTED—Sales Engineers for large industrial instrument manufacturer. Prefer men with special training in electronics and graduates of recognized engineering colleges. Will consider Mechanical and Chemical Engineers. Fine opportunity for young engineers with sales aptitude to connect with one of the fastest growing industrial instrument companies in the United States. Locations: Cleveland, New York, Chicago, and Philadelphia. Box 226, Instruments Publishing Company, 921 Ridge Ave., Pittsburgh 12, Penna.



RACK UP SUBSTANTIAL SAVINGS

With user-designed test rack sockets

Now you can test subminiature tubes in octal test rack sockets! The Sylvania subminiature tube adaptor plugs into a standard octal socket. This unique test adaptor features a movable locking ring which assures excellent lead-to-contact union.

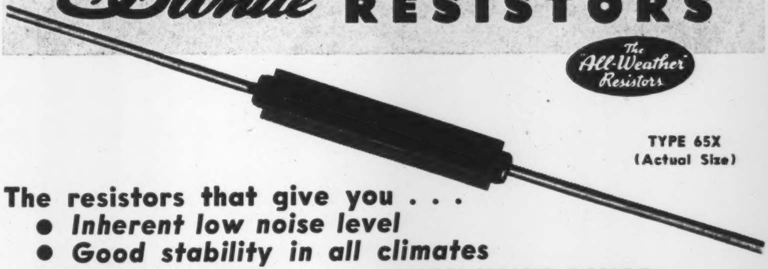
Sylvania now manufactures a complete line of test rack sockets designed especially for production testing of radio tubes. These sockets are available for 7- and 9-pin miniature tubes and octal tubes. Made of general-purpose phenolic: insulator and contacts are ruggedly constructed to withstand many tube insertions and withdrawals. For complete details write Sylvania Electric Products Inc., Dept. A-2211, Warren, Pa.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

S.S.White MOLDED RESISTORS

The All-Weather Resistors



The resistors that give you . . .
- *Inherent low noise level*
- *Good stability in all climates*

STANDARD RANGE
1,000 OHMS TO 9 MEGOHMS
These resistors are used extensively in commercial equipment, including radio, telephone, telegraph, sound pictures, television, etc. They are also used in a variety of U.S. Navy equipment.

HIGH VALUE RANGE
10 TO 10,000,000 MEGOHMS
This unusual range of high value resistors has been developed to meet the needs of scientific and industrial control, measuring and laboratory devices — and of high voltage applications.

SEND FOR BULLETIN 4906
It gives details of Standard and High Value Resistors, including construction, characteristics, dimensions, etc. Also described are S.S.White 80X Resistors, designed for extremely high voltage equipment. Copy with Price List sent on request.

THE S.S.White DENTAL MFG. CO. INDUSTRIAL DIVISION
Dept. I, 10 East 40th St.
NEW YORK 16, N. Y.
Western District Office • Times Building, Long Beach, California

Process Flow Sheets *and* Instrument Control Diagrams

Process flow sheets, process control diagrams, and engineering flow sheets can be simplified by eliminating sharp turns and intersections and by using descriptive symbols.

By W. L. WILLOUGHBY
Cities Service

PROCESS flow sheets, instrument control diagrams, and engineering flow sheets can be compared to maps. They are diagrammatic representations of the equipment and flow of product, just as the map represents localities and the flow of traffic. Conventional flow sheets and control diagrams, like a city map, have a maze of sharp turns and intersections, leading to mental fatigue and increasing the chance for human error. They can be improved by a few basic techniques.

TYPES OF DIAGRAMS

There are three types of diagrams used in process work. (1) The *process flow sheet* is a simple diagram setting forth the basic idea of the process, omitting auxiliary lines and instrument symbols. (2) The *instrument control diagram*, or *process control diagram*, as it is more commonly known, is essentially a process flow sheet with instrumentation added. (3) The *engineering flow sheet* is a detailed process flow sheet; all process equipment, instruments, valves, and piping are shown. The engineering flow sheet is used primarily by project engineers and draftsmen for making estimates and detailed drawings. It must be studied carefully to understand the basic idea of the process because that idea is hidden behind the intersections, sharp turns, and necessary details.

On the other hand, the process flow sheets and process control diagrams can be compared with improved highway layouts. There are no sharp turns or intersections. Details have been avoided. The drawing should be made with considerable forethought, giving the individual studying it the basic idea of what is being done in the process.

APPLICATIONS OF FLOW SHEETS AND CONTROL DIAGRAMS

The instrument applications engineer should have a clear picture of the process before he starts to apply the controls. However, if he is forced to make pencilled sketches of each problem before he is able to spell out the idea, he will spend many hours and possibly miss some important point. A well-made flow sheet and control diagram can be a guide and a timesaver for the instrument engineer.

The technical service man or the process engineer will study a process flow sheet or process control diagram in order to evaluate the process. He uses instruments as valuable tools and fact-finders to determine the effects of certain changes on yields, quality, etc.

Many men in the field read flow sheets at one time or another. The unit process engineer uses them constantly. Foremen and instrumentmen, like operators, seldom have the occasion to use them after the unit is in operation and they have become familiar with the process. The best use of these sheets in the Instrument Department is for new personnel or men transferred from another area because they can become familiarized with the basic idea of the process in a minimum of time. The man who is trained in this way can generally be counted upon to pick up the physical location of his equipment in a short time. For this reason the process flow sheets and control diagrams should be kept as basic as possible so that the persons reading them can get the idea of the process without wasting time and effort.

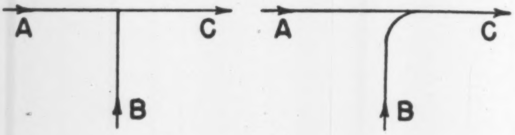


Fig. 1. A simple junction. On the left is the conventional flow symbol; on the right is an improved flow symbol.

The average instrumentman can not possibly remember all the operations in a plant, but with the aid of a good process control diagram he generally can locate trouble quickly.

METHODS FOR IMPROVING DIAGRAMS

Fig. 1 shows a simple junction of one line with another. In the left-hand diagram we see the standard intersection. Starting at point "B" and following toward the junction, we are forced to stop and think, not knowing whether to turn toward point "A" or "C." However, in the right-hand diagram there is no confusion. The eye quickly follows the curve and we proceed directly from point "B" to point "C."

Fig. 2 shows a pump on a flow sheet. In the left-hand diagram the pump suction line drops down to the left of the pump. The discharge line is on the right, rising and crossing the suction line. On the right side is shown a simpler method of indicating a pump in the process. The suction side is the large end of the pear-shaped pump symbol and the discharge side is the small end. The use of this pump symbol aids the reader to determine the direction of flow because one usually thinks of pumps having large suction and small discharge nozzles.

Fig. 3 is a flow sheet of a typical process. On the left, the reader is immediately confused by the excess lines and line crossings and by the dislocation of process equipment. On the right-hand side the confusion is eliminated. The equipment is located as it actually appears in the process

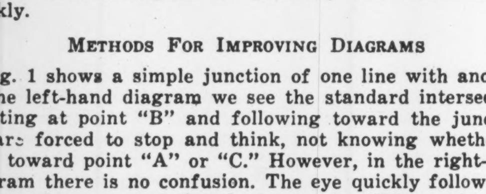


Fig. 2. Methods for showing pumps on flow sheets. Left, conventional method; right, improved method.

Presented at the Seventh Annual Symposium on Instrumentation for the Process Industries, Texas A & M College, College Station, Texas, June 2, 1952.

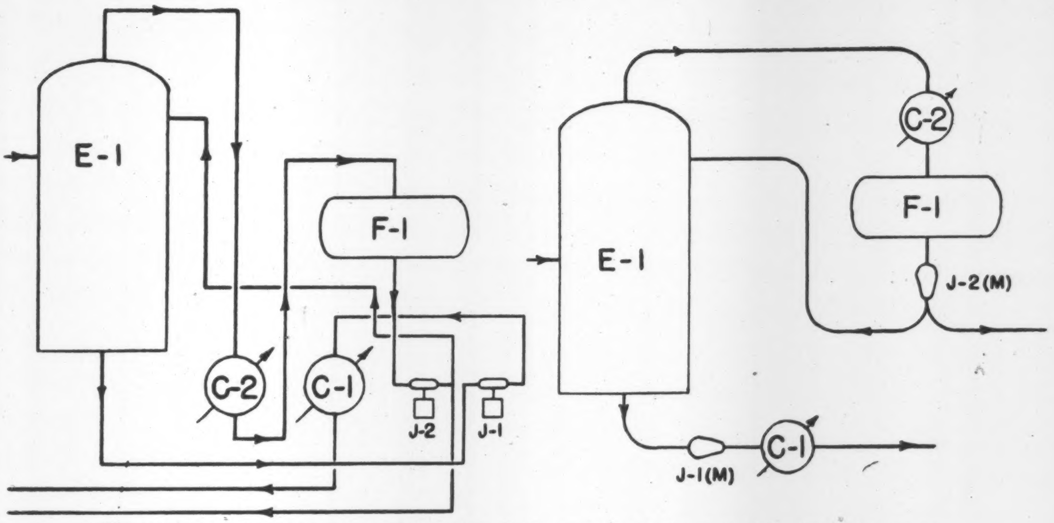


Fig. 3. Process flow sheet of a typical process. Left, conventional diagram; right, improved diagram.

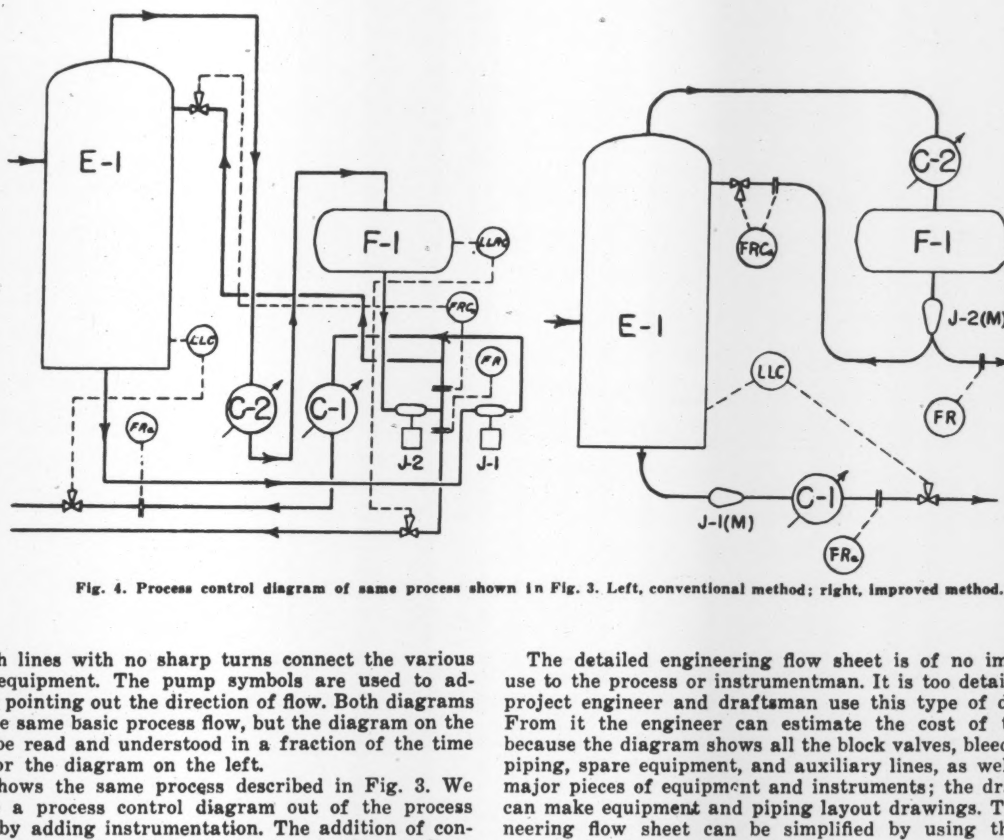


Fig. 4. Process control diagram of same process shown in Fig. 3. Left, conventional method; right, improved method.

and smooth lines with no sharp turns connect the various pieces of equipment. The pump symbols are used to advantage in pointing out the direction of flow. Both diagrams describe the same basic process flow, but the diagram on the right can be read and understood in a fraction of the time required for the diagram on the left.

Fig. 4 shows the same process described in Fig. 3. We have made a process control diagram out of the process flow sheet by adding instrumentation. The addition of control instruments in the left-hand diagram further confuses the picture. Here we have the instrument air lines, shown dotted, running parallel to and crossing the process lines. On the right side the instrument air lines never run parallel to the process lines. The instrument symbols, like the pump symbols, can be used to indicate flow directions. This is done by sloping the dotted air lines from the symbols to the valves or pressure or temperature points in the direction of process flow. Thus we have a concise picture of the process and how it is controlled.

The detailed engineering flow sheet is of no immediate use to the process or instrumentman. It is too detailed. The project engineer and draftsman use this type of diagram. From it the engineer can estimate the cost of the unit because the diagram shows all the block valves, bleed valves, piping, spare equipment, and auxiliary lines, as well as the major pieces of equipment and instruments; the draftsman can make equipment and piping layout drawings. The engineering flow sheet can be simplified by using the same techniques illustrated in Fig. 4.

Several symbols sometimes are used to indicate only one instrument—that is, there are symbols for the transmitter, receiver-recorder, the alarm, and any other part that may have been added to the basic instrument. These needless symbols make the diagram more difficult to read and understand. One symbol with proper designation can explain the control instrument required.

Continued on page 1604

LUBE-OIL Processing and Instrumentation

By
E. W. MIDLAM
and
J. D. DORSEY
Cit-Con Oil Corporation

CIT-CON, owned by Cities Service and Continental, is the largest lube-oil plant in the world for the exclusive production of high V.I. lube oils. The oil-processing facilities consist of Twin Vacuum Units for preparing five base cuts, from which are produced five grades of high V.I. lube oil by a blocked operation. The three lightest distillates are solvent refined by the largest Furfural Unit in the world, then MEK solvent dewaxed and contacted. The heaviest distillate and the short resid from the vacuum tower bottoms are solvent refined in the largest Duo-Sol Unit in the world, then MEK dewaxed and contacted. In addition to these lube-oil operations the paraffin wax from the three lightest distillates are finished to market specifications by blending, bauxite percolation, slabbing, and packaging. These operations require about 800 instruments and 450 diaphragm-motor valves.

COMPRESSOR CONTROL

Let us first discuss the compressor control at the Duo-Sol Unit. These compressors maintain a constant pressure on seven towers operating at 70 pounds Propane pressure. These towers are either distilling or stripping essentially

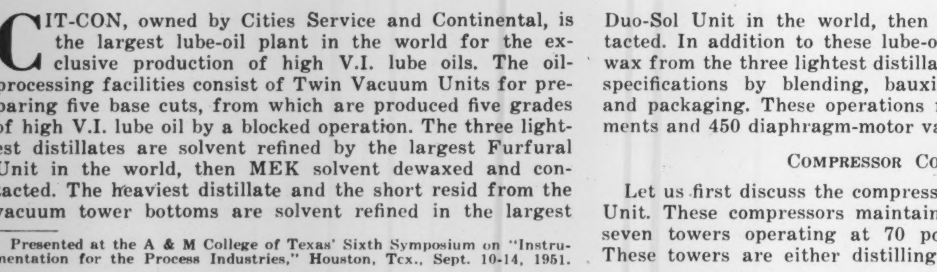

50# SUPPLY AIR TO RELAYS AND UNLOADERS
OUTPUT AIR FROM PRC-3
2.0 PSI
4.5 PSI
7.0 PSI
9.5 PSI
12.0 PSI
WORKING PRESSURE 14.5 PSI
THIS ROW OF VALVES OPEN AT ALL TIMES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
GB-3 NORTH
GB-3 SOUTH
GB-2 NORTH
GB-2 SOUTH
GB-1 NORTH
GB-1 SOUTH
1 AND 2 MAIN-3 SPARE
CLOSE ALL VALVES EXCEPT
18, 3, 10, 5, 2, 1
2 AND 3 MAIN-1 SPARE
CLOSE ALL VALVES EXCEPT
4, 7, 14, 9, 12, 11
1 AND 3 MAIN-2 SPARE
CLOSE ALL VALVES EXCEPT
18, 7, 14, 5, 16, 15

Fig. 1. Compressor loading relays.

Presented at the A & M College of Texas' Sixth Symposium on "Instrumentation for the Process Industries," Houston, Tex., Sept. 10-14, 1951.

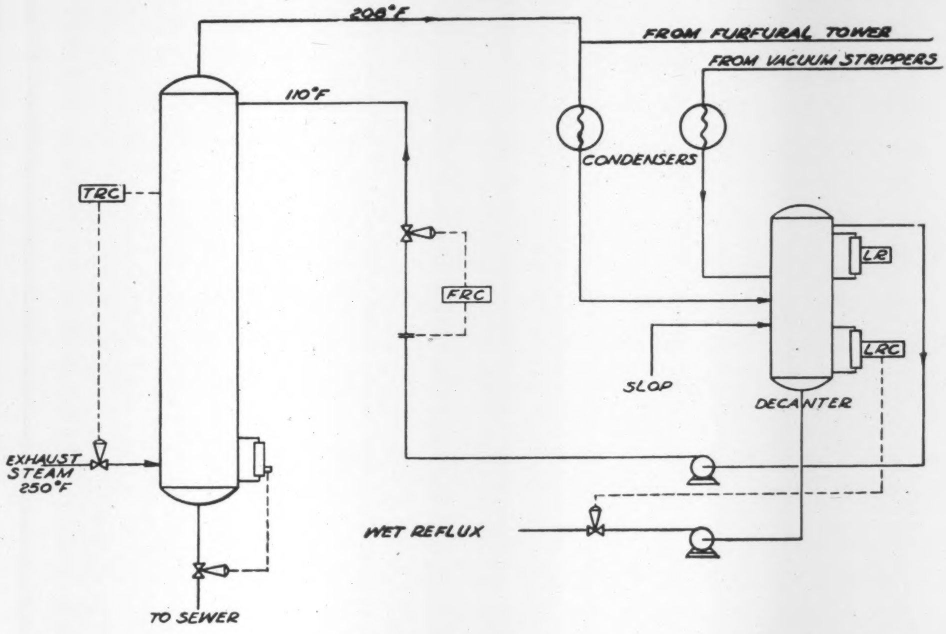

208°F
FROM FURFURAL TOWER
FROM VACUUM STRIPPERS
110°F
TRC
CONDENSERS
FRC
LR
LRC
SLOP
DECANTER
EXHAUST STEAM 250°F
WET REFLUX
TO SEWER

Fig. 2. Water-removal system, furfural unit; water-removal tower at left recovers the furfural in the water layer from the decanter.

single-boiling-point materials, such as Selecto or water, from relatively nonvolatile oils. The bottoms composition of these towers is sensitive to pressure and temperature changes; a change in pressure of a few pounds can either stop distillation or cause extremely fast distillation with the resultant danger of "pukes." One circuit in this system includes a tube still reboiler. Changes in pressure here have a tremendous effect on the system because the liquid-holding capacity of the tube still is far greater than the tower the tube still is circulating. Thus a reduction in pressure causes sudden evaporation in the tube still and a large quantity of liquid is displaced from the still into the tower. The tower bottom is on level control so the liquid pushed out of the still is passed immediately out of the tower. The return of pressure to normal means that evaporation in the tube still will be suppressed and the tower level will go low in order to refill the tube still. These points show the importance of good pressure control for this system.

Propane is continuously flashing into the 70-pound system from a 250-pound Propane system. In addition, a blow down from equipment in the 250-pound system is tied into the 70-pound system.

The three compressors handling the Propane gas in the 70-pound system are constant-speed motor-driven two-stage reciprocating compressors. The compressors are equipped with air-operated diaphragm unloaders.

The control system for maintaining a constant pressure on this 70-pound system centers around a master pressure-control instrument which supplies the impulse to operate (1) compressor unloaders, (2) compressor start-stop controls, and (3) a shut-off valve on the blow-down system. The compressor unloaders are air-operated diaphragm unloaders operating on 50-pound air. The air to the unloaders is supplied through snap-action three-way relays which are set to act in a prescribed sequence as the output air from the master pressure-control varies. The start-stop controls also

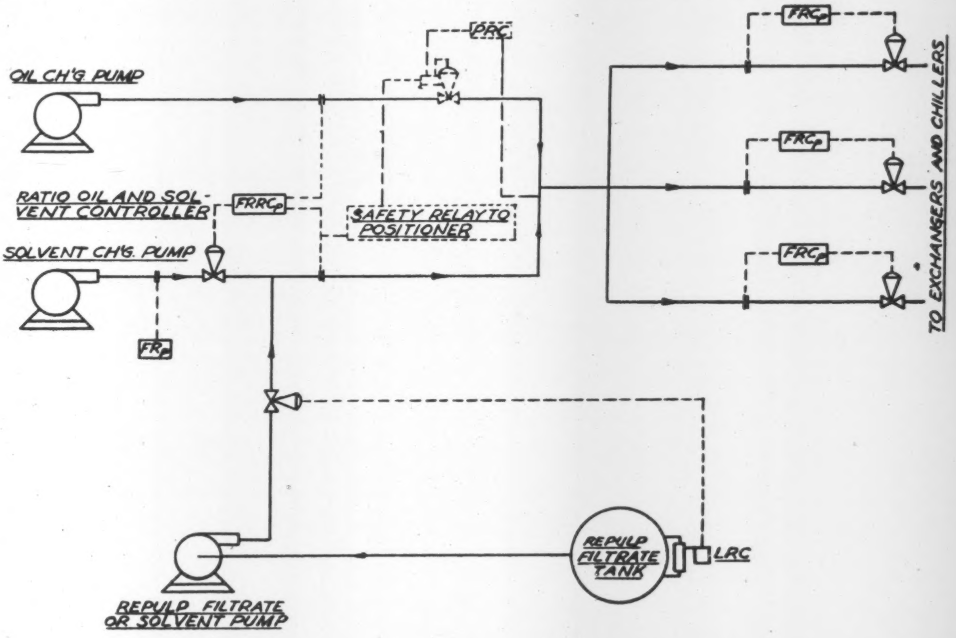

OIL CH'G PUMP
PRC
FRC_p
FRC_p
FRC_p
RATIO OIL AND SOLVENT CONTROLLER
$FRRC_p$
SAFETY RELAY TO POSITIONER
SOLVENT CH'G. PUMP
FR_p
TO EXCHANGERS AND CHILLERS
REPULP FILTRATE TANK
LRC
REPULP FILTRATE OR SOLVENT PUMP

Fig. 3. MEK-2 oil- and solvent-charge instrumentation.

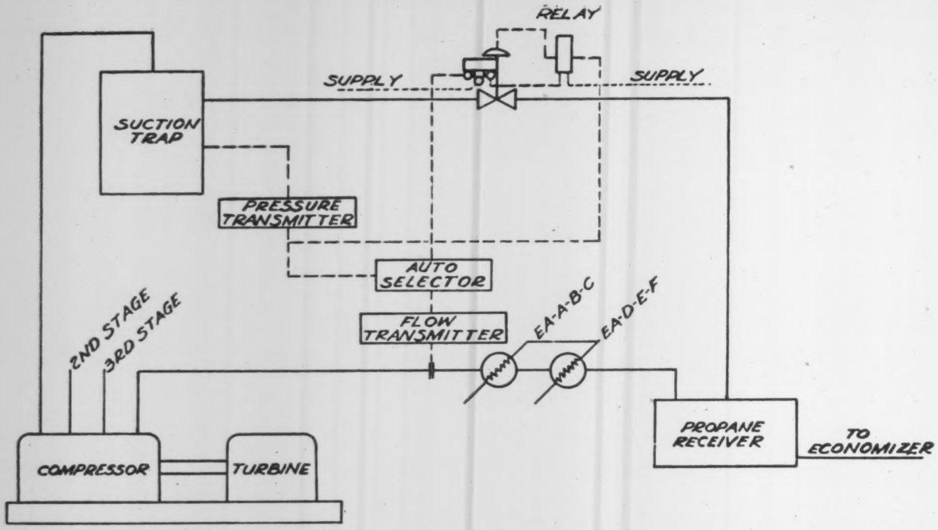


Fig. 4. Instrumentation of refrigeration Propane compressor.

fit into this sequence, as does the shut-off valve for the blow-down system.

The steps in this operation can be seen best if we assume the following conditions: The compressors are lined up in the normal way, with one compressor set for manual operation (which means it will be running at all times) and the other two compressors set on automatic operation (ready to cut in and out as required). We will also assume that pressure on the system is below the desired pressure of 70 pounds, but rising. Under these conditions the manual compressor will be running completely unloaded and the other compressors are shut down. As the pressure rises, the first set of unloaders of the running compressor load, so the compressor is half loaded. The second set of unloaders then load so the compressor is running fully loaded. As the pressure rises further, the blow-down control valve starts to close so that pressure from an outside source will be reduced. The pressure still is rising, so the second compressor starts fully unloaded. First one set of unloader then the other load up and there are two compressors running fully loaded. At this point the blow-down control valve is closed completely, shutting off any outside source of Propane. Continued rising pressure then causes the third compressor to start fully unloaded. It then will load up as described for the other compressors. In general the three compressors, fully loaded, will take care of all conditions because they are sized so that two of them will handle the normal maximum-design Propane load. If a condition should arise where all three compressors do not handle the load and the pressure continues to rise, there is a simple pressure controller on the suction trap which will open a control valve to a flare line so that pressure will be bled off before safety valves begin to pop. This is important because if the tower safeties let go, valuable Selecto vapor as well as Propane will pop.

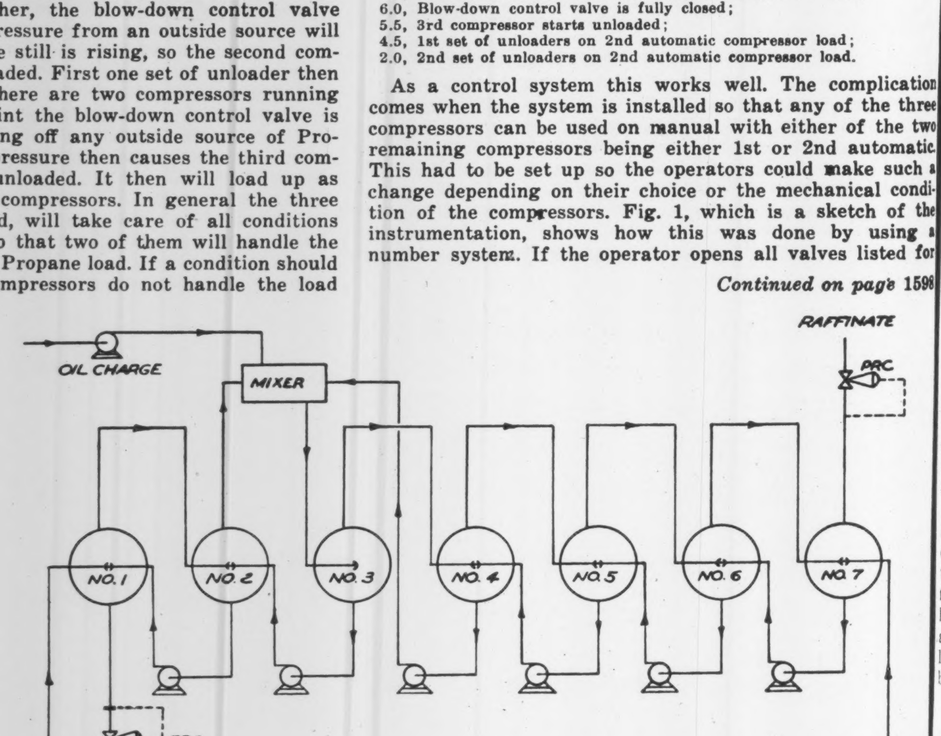
The following sequence of each operation in terms of controlled air pressure from the master pressure-controller shows the close calibration necessary for the various operations: At a pressure of

14.5, 1st set of unloaders on manual compressor load;
12.0, 2nd set of unloaders on manual compressor load;
12.0, Blow-down control valve starts to close;
10.5, 2nd compressor starts unloaded;
9.5, 1st set of unloaders on 1st automatic compressor load;
7.0, 2nd set of unloaders on 1st automatic compressor load;
6.0, Blow-down control valve is fully closed;
5.5, 3rd compressor starts unloaded;
4.5, 1st set of unloaders on 2nd automatic compressor load;
2.0, 2nd set of unloaders on 2nd automatic compressor load.

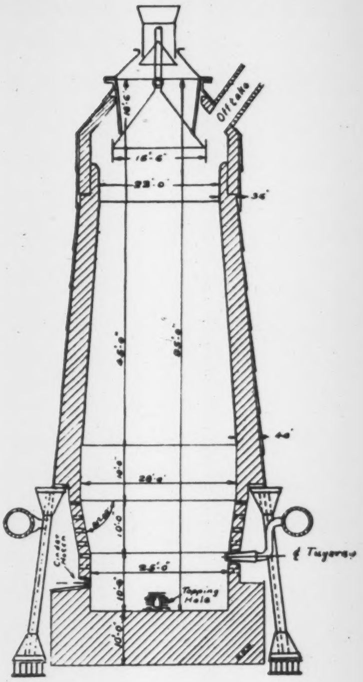
As a control system this works well. The complication comes when the system is installed so that any of the three compressors can be used on manual with either of the two remaining compressors being either 1st or 2nd automatic. This had to be set up so the operators could make such a change depending on their choice or the mechanical condition of the compressors. Fig. 1, which is a sketch of the instrumentation, shows how this was done by using a number system. If the operator opens all valves listed for

Continued on page 1598

Fig. 5. Simplified Duo-Sol extraction system.



Inwall Temperatures
of
BLAST FURNACES



By SAMUEL J. PAISLEY
National Tube Div., U. S. Steel Co.

Blast-furnace inwall temperatures can be an important guide to operating personnel. Important factors in measurement are thermocouple design, location, placement, and recording technique.

CONSIDERABLE effort has been made to measure and record blast-furnace inwall temperatures because (1) the temperature data can be used by furnace operators as an indication of change in stock movement, which affects the upward movement of the high-temperature gas, (2) dangerous channeling of the gas against the walls of the furnace is noted quickly, thus enabling the operator to take corrective steps before damage, in the form of excessive erosion, has permanently changed furnace lines, and (3) normal wear in a furnace lining can be noted over extended periods of time. In order to scan the inwall lining in the zones where greatest wear usually occurs, a minimum of six thermocouple points is selected equidistantly spaced around the circumference of the furnace shell at the same elevation. Thermocouples are inserted from 12 to 24 inches into the brickwork at these points. For convenience, the thermocouples are numbered one to six clockwise around the furnace, with the iron notch as the starting reference point.

THERMOCOUPLE LOCATIONS

As the section of lining that wears rapidly on most furnaces is the first thirty feet of unprotected inwall above the mantle (main support for the shell and top structure), it is desirable to have thermocouples installed in this region, whether water-cooled or not. The most desirable location for a single set of inwall couples is approximately ten feet above the mantle. A complete installation also would include the twenty- and thirty-foot levels above the mantle. Temperatures obtained from inwall thermocouples at levels up to thirty feet above the mantle reflect conditions of the lining or working conditions generally. Additionally, to aid the furnace personnel in determining the proper filling sequence, sizes of charges, bell dumping speed, and height of stockline, it is helpful to measure temperature at the face of the inwall a few feet below the normal stockline; quick response to furnace temperature changes can be obtained in this region.

THERMOCOUPLES

The thermocouple material generally used in the reducing atmosphere of the blast furnace is iron-constantan with primary protection of at least a 28-percent chromium-iron closed-end tube. Heavy walled protection tubes, despite their slow response to temperature change, are chosen for maximum continuous thermocouple service. Excessive replacements of either the thermocouples or protecting tubes, although not prohibitive as to cost, are impractical because safety precautions prevent accessibility to their location during operation. Access platforms must be provided for their renewal, whether frequent or not. The thermocouples usually can be replaced during stops on the furnace for minor repairs. Protecting tubes can be inspected and renewals prepared at the earliest opportunity.

Thermocouple extension lead-wire from the thermocouples to the recording pyrometer should be a No. 14 duplex lead-wire, enameled, asbestos wrap over each wire, and a weather-proof asbestos braid over-all; this affords protection against both the heat and moisture around the blast-furnace area. In addition, all lead-wire should be installed in ample-size conduit that is placed and sealed to prevent entrance of water. Wire pulled in undersized conduit can break or kink; therefore, care is urged in this part of the installation. Use conduit fittings at bends for inspection and ease of renewals. A large terminal box, located on the cast house wall, will save lead wire on renewals because the wire to the instrument from this point seldom will be found to be defective. Splicing of lead wire or use of a brass terminal box is not objectionable.

PLACEMENT TECHNIQUE

Before proceeding to methods of recording inwall temperatures, method of thermocouple placement should be considered. On a furnace rebuild the thermocouples in their protecting tubes are secured to the shell just prior to laying the adjacent courses of brick. Renewals at any other time probably will require drilling through the lining, and back tamping with a good grade of fire clay around the protecting tube. This procedure yields a good picture of lining thickness at the particular elevation of the thermocouples. As the lining cannot be depended upon to hold the thermocouples secure, some means of external fastening is required.

Continued on page 1610

Presented at the Conference "Instrumentation for the Iron & Steel Industry," April, 1952, Pittsburgh, Pa.

INSTRUMENT ELECTRONICS

The basic parts of all scientific and industrial instruments are the pickup, the amplifier, and the output device. All pickups are essentially variable resistors, capacitors, inductors, or sources of emf. Basic pickups, amplifiers, recorders, and controllers are discussed.

By MILTON H. ARONSON
Technical Editor, *Instruments*

XIV. SCIENTIFIC & INDUSTRIAL INSTRUMENTS

Electronic circuitry is being used in vast and growing amounts in instruments for the measurement and control of pressure, temperature, flow, acceleration, speed, chemical composition, humidity, and all other physical, chemical, and environmental factors. This use is expanding in both scientific laboratories and industrial plants; indeed, there no longer is a distinct boundary between scientific and industrial instrumentation. Scientific laboratories now use "industrial" recording potentiometers and controller systems; industrial plants now use "scientific" analytical and high-vacuum instruments.

The instruments can be studied logically in three parts —(1) primary elements, or pickups, (2) amplifiers, and (3) recorders and controllers. Electronics is being used widely in all three catagories.

PICKUPS

The terms "primary element" and "transducer" are commonly applied to devices which sense a measurable magnitude and change the form of energy. There is a wide and expanding variety of primary elements that change pressures, temperatures, flows, and other measurables into proportional electrical signals.

Important characteristics of pickups are: (1) impedance, (2) linearity, (3) stability, (4) frequency response, (5) required power, (6) amplitude range, (7) sensitivity, (8) weight, (9) fragility, and (10) size. The choice of a pickup for any given application is always a compromise between all these factors and the type of amplifier and recorder system available. For example, the pickup must have a frequency response such that it detects all important variations in the condition being measured. The linearity should be known; nonlinearity often can be compensated by auxiliary devices in the circuit. The sensitivity, output amplitude, and impedance determine the type and cost of the measuring circuit.

Despite the large number of pickups with electrical output, all are either a variable resistance, capacitance, inductance, or potential.

Resistive Pickups

Many pickups are available that change ohmic resistance with acceleration, chemical composition, displacement, force, humidity, light, load, position, pressure, radiant energy, strain, stress, torque, temperature, velocity, vibration, or other measurable. Typical examples of such primary elements are strain gages; photoconductive cells; potentiometers (voltage-dividing resistors); carbon piles; bolometers; constantan, nichrome, and platinum wire; conductivity cells, and thermistors. Fig. 14-1 shows some typical resistive pickups.

The sensitivity, or resistance change per unit change in the measured condition, varies greatly between types of pickups. The potentiometer-rheostat can be varied through 100 percent of its resistance value; the strain gage can be varied through only a few percent of its resistance.

Measuring Circuits For Resistive Pickups

The two most common measuring circuits used with resistive pickups are (1) the series circuit and (2) the bridge circuit, which are shown in Fig. 14-2.

In the *series* circuit the resistive pickup is in series with a source of constant potential. Variations in resistance cause changes in current or voltage, which can be measured either by a galvanometer or voltmeter. Either alternating or direct current can be used as the source potential. The advantage of this circuit is simplicity; the disadvantages are (1) the zero point of the measurement does not coincide with zero current; thus, any change in lead resistance causes spurious signals, (2) the source voltage must be kept constant, and (3) the calibration is not linear except under special conditions. These disadvantages are overcome in the bridge circuit.

The most widely used *bridge circuit* is the Wheatstone bridge circuit, shown in Fig. 14-2. The bridge can be energized by a.c. or d.c. In this circuit one of the resistors is the pickup; another resistor is made variable so that the circuit can be balanced. At the balance point no current flows through the galvanometer. As no current flows when

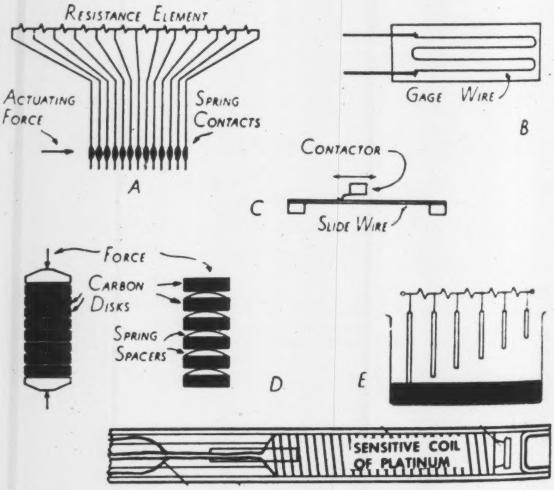
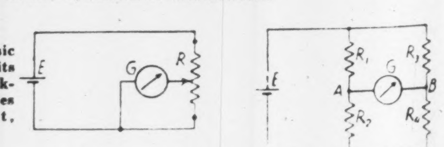


Fig. 14-1. Resistive pickups. A, tapped resistor for force or displacement measurement; B, strain gage for strain measurement; C, potentiometer-rheostat for displacement; D, carbon pile for force; E, tapped resistor for level measurement; F, resistance thermometer.

Fig. 14-2. Basic measuring circuits for resistive pickups. Left; series circuit; right, bridge circuit.



ANSWERS TO QUIZ 13.—COMMUNICATION AND TELEVISION

13-1. (c)	13- 7. (b)	13-13. (c)	13-19. (c)	13-25. (a)
13-2. (d)	13- 8. (c)	13-14. (d)	13-20. (c)	13-26. (d)
13-3. (b)	13- 9. (b)	13-15. (c)	13-21. (b)	13-27. (a)
13-4. (c)	13-10. (b)	13-16. (d)	13-22. (d)	13-28. (b)
13-5. (c)	13-11. (a)	13-17. (c)	13-23. (a)	13-29. (c)
13-6. (a)	13.12. (b)	13-18. (b)	13-24. (d)	13-30. (a)

Test Items for Quiz 14.—Page 1608

the reading is made, changes in lead resistance can introduce no error. The sensitivity of the bridge circuit is high and the circuit is used commonly with all types of resistive pickups. For example, Fig. 14-3 shows a Pirani vacuum gage. The pickup is a heated wire which changes resistance with the pressure of its atmosphere. As is commonly done in bridge circuits, a second compensating cell is used in one of the bridge legs to cancel supply variations, pickup drift, etc.

Another bridge circuit is the *Kelvin bridge*, shown in Fig. 14-4. This circuit is particularly useful for low resistances because high current flows through the unknown resistance but not through the calibrated bridge resistances. The bridge is more sensitive than the Wheatstone bridge because the IR drop across the pickup is higher. Both Wheatstone and Kelvin bridges can be excited by either alternating current or direct current. The former is not used as much as the latter because the reactive components of the arms can cause trouble.

In general, resistive pickups are less sensitive than capacitive or inductive pickups because a larger percentage change in impedance is obtained more easily with the latter types. However, as most resistive pickups are low-impedance devices, they can be made nicely stable.

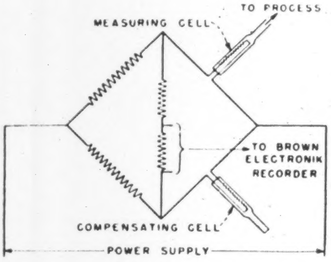

TO PROCESS
MEASURING CELL
TO BROWN ELECTRONIK RECORDER
COMPENSATING CELL
POWER SUPPLY

Fig. 14-3. Pirani vacuum cells in Wheatstone bridge circuit with output to an automatic recorder.

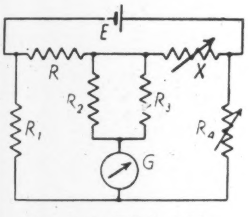

E
R
X
R₂
R₃
R₁
R₄
G

Fig. 14-4. Kelvin bridge.

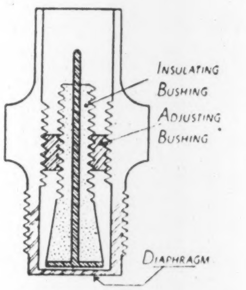

Insulating Bushing
Adjusting Bushing
Diaphragm

Fig. 14-5. Capacitive pickup for measuring pressure.

Capacitive Pickups

Pickups are available which change capacitance with chemical composition, displacement, flow, level, pressure, thickness, vibration, etc. Such variable capacitors are simply two conducting plates in which either the distance between the plates, the area of the plates, or the dielectric between the plates is varied by the condition to be measured. (See Chapter 2 for capacitor fundamentals.) Fig. 14-5 shows a capacitive pickup for measuring pressure; pressure on the diaphragm changes the distance between the two plates of the capacitor.

Measuring Circuits for Capacitive Pickups

The most common measuring circuits used with capacitive pickups are (1) impedance bridges and (2) oscillators.

Impedance bridges are similar to Wheatstone resistance bridges in principle, but the arms have reactances (capacitors or inductors) rather than resistors. Fig. 14-6 shows a Foxboro bridge circuit for capacitive measurements of material thickness. The material to be gaged passes between the plates of the measuring capacitor, which is in a bridge circuit. Two arms are low-impedance transformer windings; the other two are the measuring capacitor (the pickup) and the rebalancing capacitor. The low impedance of the transformer reduces the effect of capacity to ground and leakage along the leads from the measuring capacitor to the instrument proper.

In *oscillator circuits*, the pickup capacitor is a part of a frequency-determining resonant tank; thus changes in capacity cause changes in frequency, which can be measured by frequency discriminators or heterodyne methods. Fig. 14-7 shows the circuit of the Foxboro "Dynalog" recorder. Both the measuring capacitor and rebalancing capacitor are operated at 1.7 Mc. and modulated at 60 cps. The two 1.7-Mc. signals are heterodyned in the diode detector. Any change in the measuring capacitor causes a 60-cps. signal to appear at the detector, which signal is used to rebalance the balancing capacitor. Operation at the high radio frequency (1.7 Mc.) gives a large output signal for small changes in capacitance.

When the oscillator circuit operates at a high frequency, the circuit has high sensitivity; movements of a few billionths of an inch by a plate can be detected, or small variations in the dielectric can be detected. As with all high-sensitivity systems, stability becomes a problem. Bridge circuits, which are symmetrical and thus balance out power-supply drift, cable effects, etc., usually have higher over-all system stability than oscillator circuits, although the latter have higher sensitivity.

Capacitive pickups are usually high-impedance devices, in contrast with resistive pickups, which can be of low impedance. As high-impedance devices are inherently less stable than low-impedance devices, capacitive pickups are inherently less stable than resistive types. However, they usually are more sensitive.

Inductive Pickups

Inductive pickups are available for measurement of acceleration, displacement, flow, force (torsion bar plus differential transformer), level, position, pressure, rotation, strain, tension, thickness, velocity, and vibration. They operate by changing either self-inductance or mutual inductance—usually by changing the reluctance of a part of their associated magnetic circuits. (See Chapter 2 for

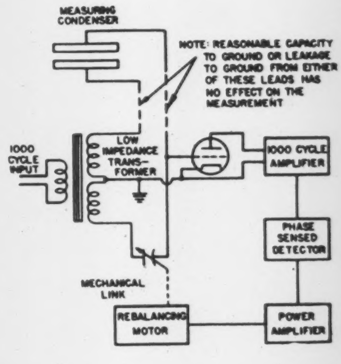

MEASURING CONDENSER
NOTE: REASONABLE CAPACITY TO GROUND OR LEAKAGE TO GROUND FROM EITHER OF THESE LEADS HAS NO EFFECT ON THE MEASUREMENT
1000 CYCLE INPUT
LOW IMPEDANCE TRANS-FORMER
1000 CYCLE AMPLIFIER
PHASE SENSED DETECTOR
MECHANICAL LINK
REBALANCING MOTOR
POWER AMPLIFIER

Fig. 14-6. Foxboro bridge circuit for capacitive measurements.

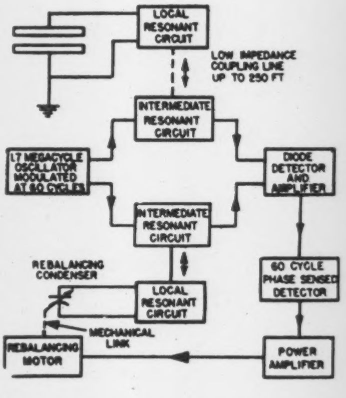

LOCAL RESONANT CIRCUIT
LOW IMPEDANCE COUPLING LINE UP TO 250 FT
INTERMEDIATE RESONANT CIRCUIT
1.7 MEGACYCLE OSCILLATOR MODULATED AT 60 CYCLES
DIODE DETECTOR AND AMPLIFIER
INTERMEDIATE RESONANT CIRCUIT
REBALANCING CONDENSER
LOCAL RESONANT CIRCUIT
60 CYCLE PHASE SENSED DETECTOR
MECHANICAL LINK
REBALANCING MOTOR
POWER AMPLIFIER

Fig. 14-7. Foxboro "Capacity Dynalog" recorder which uses heterodyne principle.

description of reluctance and magnetic paths.) For example, the *self-inductance* of the coils shown in Fig. 14-8 depends on the position of the iron core or movable armature, which changes the reluctance of the magnetic path. These devices are easily converted to more stable, more sensitive, and more linear push-pull operation, as in Fig. 14-9. These types sometimes are called inductance-ratio pickups; the *differential transformer* is used widely for many types of measurements. Pickups with such push-pull outputs can be used directly in bridges to give doubled output sensitivity.

Fig. 14-10 shows pickups (for detecting thickness of materials) which operate by change of mutual inductance —that is, the signal induced in one coil depends on the position of the nearby coil or armature.

The pickups shown in Figs. 8, 9, and 10 must be energized by an external source of alternating current; their output signal can have frequencies from d.c. up to a fraction (about one fourth) of the excitation frequency. In contrast, velocity-type pickups (Fig. 14-11) use a magnetic field in which the coil or armature moves. The output signal depends on the *rate* at which flux lines are cut; hence the pickup is sensitive to the velocity of the coil and not to the displacement, as in the other types illustrated. Familiar velocity-type inductive transducers are the permanent-magnet loudspeaker and the dynamic microphone.

Another reluctance pickup is the magnetic thickness gage, shown in Fig. 14-12. The thickness of the plate being measured determines the reluctance of the magnetic path and hence the flux density, which is indicated by the indicator.

Inductive pickups are used in series circuits or bridge circuits (Fig. 14-13). The series circuit is used in industrial applications because of its simplicity and low cost. However, it is less sensitive and less accurate than the bridge circuit. The phase-responsive bridge circuit is used commonly in instruments in which the unbalance signal (caused by motion of one core) is used to restore bridge balance by causing follow-up motion of the other core. The former core can be attached to floats in level detectors, bells of flow detectors, etc., as in Fig. 14-13. This bridge circuit is used also to transmit measurements over considerable distances.

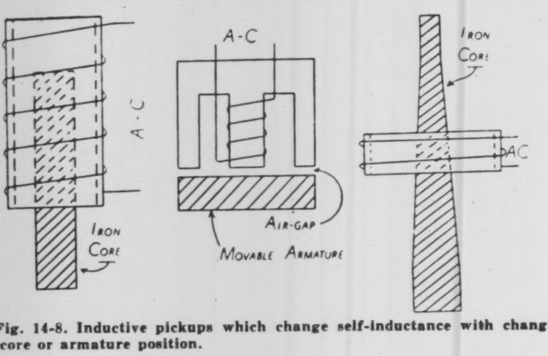


Fig. 14-8. Inductive pickups which change self-inductance with change in core or armature position.

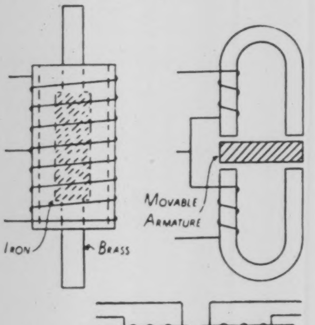


Fig. 14-9. Inductive pickups for push-pull output; type on left is called the differential transformer.

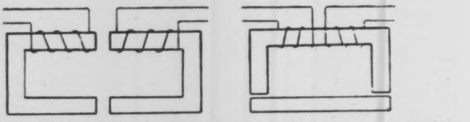


Fig. 14-10. Inductive pickups which measure thickness of materials or displacement by change of mutual inductance.

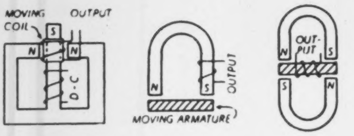


Fig. 14-11. Velocity-type inductive pickups.

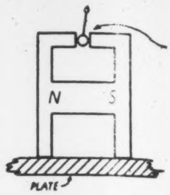


Fig. 14-12. Magnetic thickness gage. Arrow points to flux indicator.

Inductive pickups are extremely stable because of their low ohmic resistance. With bridge circuits they are accurate as well as stable.

Potential-type Pickups

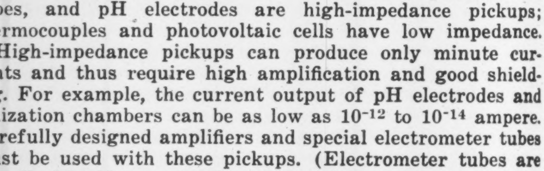
Ionization chambers, piezoelectric crystals, photoemissive tubes, photovoltaic cells, pH electrodes, and thermoelectric couples are potential-type pickups which develop an emf. proportional to the measurable. Pickups of this type are available for measurement of acceleration, displacement, light, pH, pressure, radiation, surface variation, temperature, vacuum, and vibration. Fig. 14-14 shows a photoemissive tube controlling edge position of a moving strip. When the edge moves laterally it changes the intensity of the light falling on the sensitive surface of the phototube, causing proportional changes in output voltage. Fig. 14-15 shows pH electrodes which develop an emf. proportional to the pH of the solution.

Resistive and inductive pickups are usually low-impedance devices; capacitive pickups are high-impedance devices; potential-type pickups can be high or low impedance—ionization chambers, piezoelectric crystals, photoelectric tubes, and pH electrodes are high-impedance pickups; thermocouples and photovoltaic cells have low impedance.

High-impedance pickups can produce only minute currents and thus require high amplification and good shielding. For example, the current output of pH electrodes and ionization chambers can be as low as 10^{-12} to 10^{-14} ampere. Carefully designed amplifiers and special electrometer tubes must be used with these pickups. (Electrometer tubes are described in Chapter 8.) In contrast, low-impedance pickups such as thermocouples can be applied directly to galvanometers or milliammeters and require much less amplification.

AMPLIFIERS

The signals from most of the pickups described require some amplification before they are big enough to operate



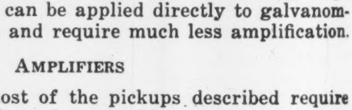

ARMATURE ROD TO CHARACTERIZED BELL
TO PEN ARM
COUNTERWEIGHT
ROCKER ARM
KNIFE EDGE BEARING
A.C. LINE
TRANSMITTING COIL AND ARMATURE IN METER BODY
RECEIVING COIL AND ARMATURE IN RECORDER

Fig. 14-13. Basic circuits for use with inductive pickups. Left, series circuit in which reactance of meter winding depends on height of mercury; right, phase-sensitive bridge circuit; bottom, Brown inductance bridge for remote indication of flow.

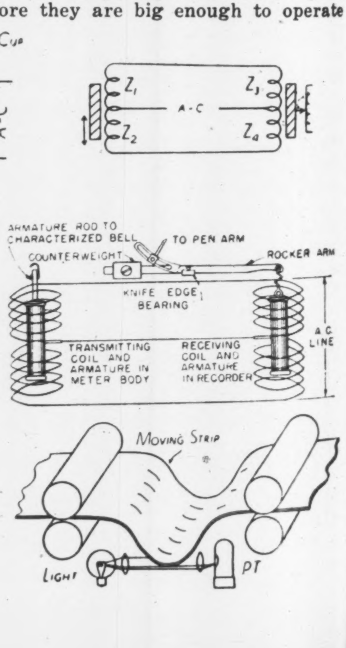


Fig. 14-14. Photoemissive tube controlling edge position of a moving strip.

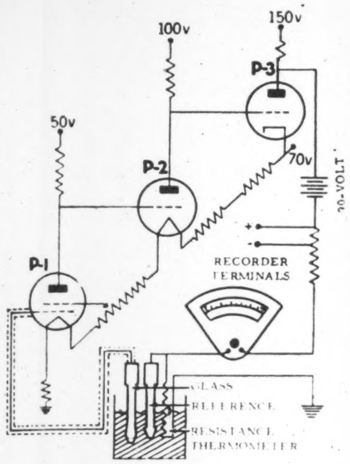


Fig. 14-15. The Beckman miniature pH meter, showing sensitive glass electrode, reference electrode, and direct-coupled amplifier. The resistance thermometer is for automatic temperature compensation.

indicators, recorders, or control motors. Amplifiers can be classed as a-c. or d-c. amplifiers, and as voltage or current amplifiers. (See Chapter 8 for amplifier factors.)

Most amplifiers have voltage-amplification stages followed by power amplifiers. The former boost the voltage of the signal; the later boost the current so that the signal can operate milliammeters or control motors. For example, in the circuit of Fig. 14-15, the first two tubes are voltage amplifiers and produce low current outputs; the final tube has low voltage gain but larger current output.

A-c. amplifiers are usually R-C-coupled amplifiers with negative feedback for stability. A wide variety of a-c. amplifiers are available for use with various pickups. Important amplifier characteristics are (1) gain, (a) frequency response, or bandwidth, (3) stability, and (4) noise level. An amplifier is always a compromise between the four characteristics. For example, gain can be increased only at the expense of stability; bandwidth can be increased only at the expense of noise level. (A-c. and d-c. amplifiers are described in Chapter 8.)

D-c. amplifiers are of two basic types—(1) direct coupled and (2) chopper, or breaker, type. Fig. 14-15 shows a direct-coupled amplifier. It is difficult to obtain stability in direct-coupled amplifiers with more than two or three stages; all of the various voltage references must be extremely stable.

Chopper-type amplifiers are d-c. amplifiers which overcome the stability problem of direct coupling by chopping the input d-c. signal into an a-c. signal, as shown in Fig. 14-16. The conversion usually is done by a mechanical solenoid-operated chopper, which is called a converter or breaker. The a-c. signal then is amplified in a stable high-gain R-C-coupled a-c. amplifier. An output breaker operating in synchronism with the input breaker can convert the a-c. signal back into a d-c. signal. Mechanical-type choppers usually operate between 400 and several thousand operations per second, producing a signal of the same frequency. Other types of converters are available for converting the d-c. signal into higher-frequency signals. Although the use of a chopper eliminates the stability problem of direct-coupled stages, the chopper introduces noise and increases the noise level of the amplifier.

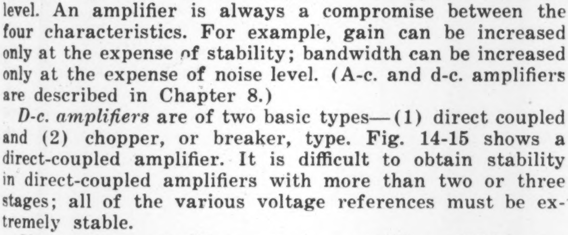


Fig. 14-16. Principle of chopper-type d-c. amplifiers.

Bandwidth and Noise

Many problems arise in the design of an amplifier which must amplify a signal of only a fraction of a microvolt or of a micromicroampere. The noise level of the amplifier must be reduced until the noise is smaller than the signal. The ultimate minimum noise level of an amplifier is the thermal agitation noise in its input circuit. As this thermal noise is uniformly distributed throughout the frequency spectrum, it is proportional to the bandwidth of the amplifier. Thus it is desirable to keep the bandwidth as low as possible. For this reason, some instruments use low-frequency chopping of the d-c. signal, even though amplification of the low-frequency signal requires bulkier amplifier components. Other methods for reducing noise include keeping the input impedance low and using non-microphonic components.

Low-frequency chopping is done in some infrared analyzers (Fig. 14-17), in which the infrared beam of light is chopped at a frequency of only 10 or 20 times per second before the beam is passed through the gases in the cells. Absorption of the beam by the gases or fluids is a measure of the composition of the sample. Note that two symmetrical paths are provided so that a stable bridge-type measurement is possible. In this technique the bandwidth of the amplifier can be made as small as a few cycles per second, thus reducing noise to an infinitesimal amount.

AUTOMATIC RECORDERS

Perhaps the most familiar electronic circuit in industry is that in self-balancing bridge and potentiometer electronic recorders. These recorders are servo-operated devices in which a motor is driven by the unbalance signal to restore the circuit balance—that is, both are null-seeking devices. They are used with practically all of the pickups described. Bridge recorders are used with resistive, capacitive, or inductive pickups; potentiometer recorders are used with potential-type pickups.

Bridge Recorders

Fig. 14-18 shows the components of a bridge recorder. The primary element is any resistive pickup. The bridge is energized with a.c. from a transformer. Any change in resistance of the primary element unbalances the bridge, causing a 60-cycle signal to be delivered to the electronic amplifier. The output of the amplifier controls a balancing motor which rebalances the bridge by moving the slidewire contact and simultaneously moving the recording mechanism. Motors of low inertia are used so that full-scale deflection can be obtained in a fraction of a second.

The Bailey "Pyrotron," Brown "Electronik," Foxboro "Dynalog," Leeds & Northrup "Speedomax," and Weston "Model 67001" recorders all use the servo princple, with variations in technique. The Foxboro, for example, uses a bridge circuit with two resistors (one of which is the pickup) and two capacitors (as in Fig. 14-6). When the bridge is unbalanced by change in pickup resistance, balance is restored by changing the rebalancing capacitor. A balancing capacitor is used in order to eliminate the slidewire with its mechanical contact.

Continued on page 1606

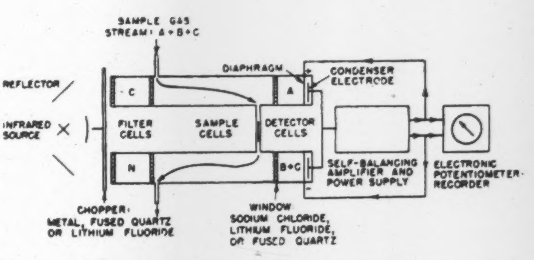

SAMPLE GAS STREAM: A+B+C
DIAPHRAGM
CONDENSER ELECTRODE
REFLECTOR
C
A
+
INFRARED SOURCE
FILTER CELLS
SAMPLE CELLS
DETECTOR CELLS
N
B+C
-
SELF-BALANCING AMPLIFIER AND POWER SUPPLY
ELECTRONIC POTENTIOMETER-RECORDER
CHOPPER: METAL, FUSED QUARTZ OR LITHIUM FLUORIDE
WINDOW SODIUM CHLORIDE, LITHIUM FLUORIDE, OR FUSED QUARTZ

Fig. 14-17. Infrared analyzer in which the infrared beam is chopped before passing through the sample and reference cells.

TANK-O-METER
FOR MEASURING TANK
CONTENTS ANY DISTANCE AWAY

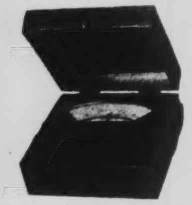
ANY LIQUID

HYDROSTATIC GAUGES
FOR ALL PURPOSES

PRESSURE • VACUUM • DRAFT
DEPTH & ABSOLUTE PRESSURE
BAROMETRIC PRESSURE
DIFFERENTIAL PRESSURE
SEND FOR BULLETINS

UEHLING INSTRUMENT CO. 470 GETTY AVE., PATERSON, N. J.

TEST YOUR MAGNETIC CIRCUITS



RAWSON FLUXMETER
TYPE 504

The only portable fluxmeter available which returns rapidly to zero when a single button is depressed. Simple and fast in operation. Convenient and light in weight.

Not limited to a single type of measurement. Has universal application for laboratories or production. Measures strength of magnets and electromagnets, permeability and hysteresis loops for iron and steel, total flux lines in circuit, flux lines developed in air gap, etc.

Has a mechanical clamp to protect the pivots and jewels when in transit.

RAWSON ELECTRICAL
INSTRUMENT COMPANY
112 POTTER STREET, CAMBRIDGE 42, MASS.

CLEAN OVER 400 UNITS HOURLY

A widely known electrical manufacturer CHEMICALLY CLEANS 1 UNIT EVERY 8.3 SECONDS. Costly reprocessing due to dirty units is eliminated. Production lines operate at better efficiency peaks.

ENG-SOL METHOD CAN SOLVE YOUR PROBLEM

The ENG-SOL Method may be the answer to your precision instruments cleaning problem. Our bulletin "Precision Cleaning" describes this new high-velocity compressed air method of cleaning. Write for it today.

PASSAIC ANALYTICAL
LABORATORIES, Inc.
228 Aycrigg Ave. Passaic, N. J.

ENGINEERS

The Electric Auto-Lite Company offers a fine opportunity to graduate Mechanical or Electrical Engineers with several years instrument design experience to become fully fledged development engineers with commensurate income.

Our products are used by all of the major industries of the nation and the world. There are openings in our Central Engineering Department, Toledo, Ohio, and at our Instrument Division in Wisconsin.

Men with initiative and ability and an urge to reach the top of their profession should contact Mr. G. P. Robinson, Personnel Director, The Electric Auto-Lite Company, Toledo 1, Ohio, for an interview.

INSTRUMENT EVENTS Calendar

Dec. 3-5

Annual Meeting and Exhibits, Society for Experimental Stress Analysis, Hotel McAlpine, New York City. For information write W. M. Murray, Sec.-Treas., P.O. Box 168, Cambridge 39, Mass.

Dec. 1-6

20th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, N. Y.

Dec. 30-31

119th Meeting, American Meteorological Society, St. Louis, Mo. For information write Kenneth C. Spengler, Ex. Sec., 3 Joy St., Boston 8, Mass.

December 10-12

Annual Computer Conference. Park Sheraton Hotel, New York. For information write B. F. Osbahr, Room 639, 480 Lexington Ave., New York City, N. Y.

1953

Jan. 14-16

Third Conference on High-frequency Measurements. Sponsored by AIEE, IRE, and NBS. To be held in Washington, D. C.

January 29-31

Eighth Annual Symposium "Instrumentation for the Process Industries" Agricultural & Mechanical College of Texas, College Station, Texas. For information write Dr. P. G. Murdoch, Director of the Symposium.

Jan. 26-29

120th Meeting, American Meteorological Society, New York, N. Y. For information write Kenneth C. Spengler, Ex. Sec., 3 Joy St., Boston 8, Mass.

Jan. 26-30

Twenty-First Annual Meeting, Institute of Aeronautical Sciences, Hotel Astor, New York, N. Y. For information write Robert R. Dexter, Sec., 2 East 64 St., New York 21, N. Y.

Feb. 4-6

First meeting Western Computer Conference sponsored by joint Computer Conference Committee of Institute of Radio Engineers and the American Institute of Electrical Engineers. Hotel Statler, Los Angeles, Calif.

Feb. 2-6

Sixth Annual Symposium on Modern Methods of Analytical Chemistry, Louisiana State University, Baton Rouge, La.

Feb. 18

Annual Meeting, New York Section, Instrument Society of America, Statler Hotel, New York, N. Y. For information write R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y.

Mar. 2-6

Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, William Penn Hotel, Pittsburgh, Pa. For information write L. E. Pitzer, c/o U. S. Steel Co., 525 Wm. Penn Place, Pittsburgh 30, Pa.

Mar. 17-19

121st Meeting American Meteorological Society, Atlantic City, N. J. For information write Kenneth C. Spangler, Ex. Sec., 3 Joy St., Boston 8, Mass.

March 23-26

I.R.E. National Convention & Radio Engineering Show. Grand Central Palace, New York, N. Y. For information write W. Copp, 303 West 42 St., New York 18, N. Y.

Mar. 23-25

13th Annual Meeting, American Congress on Surveying and Mapping, Hotel Shoreham, Washington, D. C. For information write Walter Dix, Ex. Sec., Box 470, Benjamin Franklin Sta., Washington 4, D. C.

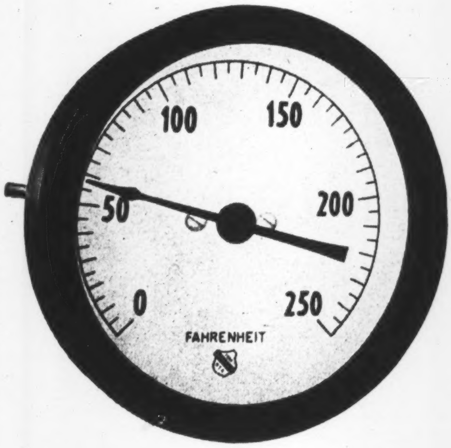
September 21-25

Eighth National Instrument Conference & Exhibit, Sherman Hotel, Chicago, Ill. For information write P. V. Jones, Mgr., Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.

FOR EASY-TO-READ "ON THE SPOT" TEMPERATURE INDICATION, CHOOSE

Accurate

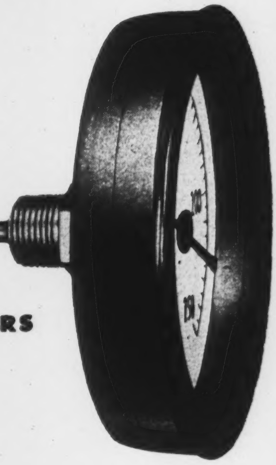
AMERICAN BI-METAL DIAL THERMOMETERS



STOCKED AND SOLD

BY

LEADING DISTRIBUTORS



SPECIFIC NEEDS of refinery, chemical, power and other plants are met completely by American Bi-Metal Dial Thermometer. It makes accurate "on the spot" temperature readings easy *even from a distance.* It can be used where other types are not nearly so practical — and to avoid the higher cost of a distant reading thermometer. Installation is simple, fast and economical — only a ½" or ¾" N.P.T. tapped hole is required.

The fixed stem contains the highly sensitive bi-metal element. Accuracy of the instrument is guaranteed within 1% of the scale range. In extensive laboratory and field tests, sudden hot blasts, submersion, severe mechanical and thermal shocks, hot gases, dust and long exposure to the elements could not impair its accuracy or destroy the hermetic seal of the case.

Solve your "on the spot" temperature reading problems with rugged, accurate American Bi-Metal Thermometers. Two dial sizes, seven stem lengths, a wide range of temperatures, and the availability of separable sockets make selection easy. Get all the facts. Write for Bulletin 144.

SPECIFICATION DATA

Temperature Ranges: from minus 60° to 120°F., 200° to 1000°F. **Dial Sizes:** 3½" and 5". Graduations over full 270° arc: **Bezel:** Screwed to case. **Front:** Heavy plate glass set in channelled gasket — hermetically seals the case. **Pointer:** Adjustable type attached with set screw; easy to get at for setting. **Stem:** Stainless steel, ¼" diameter — lengths from 2½" to 24". Stem and connections welded — strong, corrosion resistant, leak-proof. **Connection:** Fixed, ½" N.P.T.

Separable Sockets available for use on closed systems or where the measured medium is corrosive to the stainless steel stem. Fit over all standard stem lengths except 2½".

1850
AMERICAN
U.S.A.

AMERICAN INDUSTRIAL INSTRUMENTS

MAXWELL
MANNING
MMM
& MOORE INC.
TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT
MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

Here's why
it pays to know your
HSM
HONEYWELL SUPPLIES MAN
HSM
PYROMETER SUPPLIES
Honeywell
HSM
Brown Thermocouple Wells
Honeywell

Every instrument man will find these catalogs invaluable . . . packed with facts on thermocouples, wells, tubes, thermocouple and extension wire, and prices. Send for your copies today.

W. J. Kirby, Honeywell Supplies Man in the Los Angeles area, helps Mr. F. P. Edmonds of Lever Bros. Co. to select the correct precision-made thermocouple well from the wide selection covered in the Honeywell catalog—as part of the thorough, individualized service provided by the HSM plan.

Complete application and pricing information on all products, personal cooperation in establishing your own plant's requirements . . . these are but two of the ways that this plan can bring new convenience and economy to your pyrometer supplies purchasing.

Your local Honeywell Supplies Man will be glad to show you how planned buying . . . *the HSM way* . . . can help you lick your supplies problems. Call him today . . . he is as near as your phone.

Minneapolis-Honeywell Regulator Co., *Industrial Division*, 4482 Wayne Ave., Phila. 44, Pa. Stocking points in Phila., Cleveland, Chicago, Atlanta, Houston, Los Angeles, and San Francisco.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

H
HONEYWELL

● *Important Reference Data*

Write for Catalog 200-2 on Thermocouple Wells . . . and for new Pyrometer Supplies Buyers' Guide No. 100-4

INSTRUMENT SOCIETY of AMERICA Journal

National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pennsylvania

Vol. 8 November 1952 No. 11

EXECUTIVE BOARD

President
A. O. Beckman

First Vice-President
W. A. Wildhack

Vice-President
D. M. Boyd, Jr.

Vice-President
N. L. Isenhour

Vice-President
R. T. Sheen

Secretary
Porter Art

Treasurer
G. R. Feeley

Past President
J. B. McMahon

CONTENTS

Report of Vice-President 1580

Employment Service 1581

Sections Data 1580

Measurements in Tractor Design and Development 1582
By R. P. Wehrle

Research vs Industrial Instrumentation 1587
By Delmas C. Little

Report of N.L. Isenhour, Vice President

Mr. N. L. Isenhour, vice-president, Supervising Operating Division for 1952 reports on the following committees. The committees include: the Meetings Committee, the Finance Committee, and the Publications Committee.

Meetings Committee
Chairman: E. J. Grace, Jr.

This committee has been working very close with the Cleveland Section in preparation for the Seventh Annual Conference; also, some work has been done on the Chicago Conference in 1953.

A survey of the exhibitors indicated that it was desired by the majority that the 1957 show be held in New York City. The date for the show will be August 26 through 30, inclusive.

Finance Committee
Chairman: J. T. Volbrecht

The committee's report indicates that the society is continuing to operate on a sound financial basis. Several recommendations for increasing the society's income were included and they are as follows:

1. Special drive for corporate members.
2. Production of additional educational films.
3. Offer the proceedings for sale at the time of registration at the conference with the understanding that they be published at the earliest possible date.

Publications Committee
Chairman: C. W. Covey

The committee processed the following for publication:

1. Committee Report — "Industrial Training Course Outline".
2. Six Recommended Practices.
3. Four 1951 Conference Papers.
4. Thirty-six Conference Papers.

Also prepared a report setting forth responsibilities, duties, and policies of the Publications Committee. This report, upon approval of the executive board will be used as a guide by the committee in any of their future operations.

A complete set of instructions to authors for use in preparation of technical papers is being prepared and when approved by the executive board will be sent to each prospective conference speaker as a guide for preparing his paper for publication.

Educational Courses Offered I.S.A. Members

In collaboration with the St. Louis Section, Washington University is repeating the course in Instrumentation and Control. Theory and application of measuring and controlling flow, liquid level, temperature, pressure, and other variables will be covered extensively.

* * *

Again this year the Newark College of Engineering is offering evening courses in Individual Instrumentation. The Educational Committee of the New Jersey Section of I.S.A. has cooperated with Newark College in organizing these courses, which are offered as part of the Special Courses Program at the college.

* * *

For those members of I.S.A. who may be interested in taking a special course in Instrumentation, the Metropolitan Section of A.S.M.E. is offering a course in Components and Techniques in Automatic Controls. This course includes a "down-to-earth" symposium stressing application, practical methods, and operational data on newest components of servomechanisms, closed-loop, and automatic control systems. Selection, application, pertinent characteristics, ranges of operation, accuracy and limitations.

J. Riggs

Chicago Section announces with regret the sudden death of one of its members, J. Riggs. Mr. Riggs joined the Society in 1946, and was employed by General Meters and Controls, 205 W. Wacker Drive, Chicago, Ill.

Instrument Society of America

1319 ALLEGHENY AVENUE • PITTSBURGH 33, PA.

Please send me............copies of the Proceedings of the Seventh National Instrument Conference, held at Cleveland, Ohio, September 8 to 12, 1952.

Price $5.00 to ISA members. $10.00 to all others.

Name ....

Street ....

City.. **State**..................

ISA Member - Yes ☐ **No** ☐ **Payment herewith** ☐ **Send bill** ☐

Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P.M., U. of Akron, Ayer Hall, Rm. 212-B.
November 25, "Measurement and Control of Pressure"

ALBUQUERQUE
J. F. Cox, 209 General Hodges Road, N. E., Albuquerque, New Mexico.
First Monday, Meeting at 8:00 P.M., Mitchell Hall, Univ. of New Mexico.

ARUBA
J. L. Lopez P. O. Box 208, c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I. Tel. 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
M. Virgil Davis, 357 Sixth St., N.W. Atlanta, Ga. Tel. EM. 3042
Fourth Friday, Meeting 7:30 P.M., Electric Bldg., Georgia Power Co.

BALTIMORE
G. B. Greer, 681 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's Club of Baltimore.

BATON ROUGE
G. M. McCarroll, 1818 Edinburgh Ave., Baton Rouge 6, La.
Meeting monthly, L.S.U. Physics Bldg.

BOSTON
Robert V. Meyer, Box 111, S. Lincoln, Mass., Tel: Lincoln 6-0167 M
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 7:30 P. M., 99 Club, 99 State St.

CALIFORNIA
Gerald B. Miller Company, 1544 Highland Ave., Hollywood 28, Calif., Tel. Hollywood 9-6305
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M. Pasadena Elk's Club, 400 West Colorado St., Pasadena

CAROLINA PIEDMONT
L. Frank Lawrence, Minneapolis-Honeywell Regulator Co., 2400 Wilkinson Blvd., Charlotte, N. C., Tel: 5-4422
Second Friday, Dinner at 7:30 P.M., Meeting at 8:30 P.M. Cardinal Restaurant, Charlotte.

CENTRAL ILLINOIS
Thomas A. Carroll, 721 Hurlburt St., Peoria, Ill., Tel: 4-8909
Second Wednesday, Some dinner meetings at 6:30 P. M., Meeting at 7:30 P. M.

CENTRAL INDIANA
Norman Krone, 123 N. Grant Ave., Indianapolis, Ind. Tel: IRvington 5337
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
H. G. Murray, 169 Durston Ave., Syracuse 6, N. Y. Tel: 9-9259
Third Monday, Dinner at 6:00 P. M., Meeting at 8:00 P. M.

CENTRAL OHIO VALLEY
J. C. Dilliner, 818 Winton Ave., Belpre, Ohio Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-Way Grille, Rt. #2, about 3 miles south of St. Mary's, W. Va.

CHARLESTON
D. A. Cunningham, 5140 Washington Ave., S.E., Charleston, W. Va. Tel. 55403
First Monday, Dinner at 6:15 P.M., Meeting at 8:00 P.M., Kanawha Airport Terminal

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-6686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Maintenance and Operation of Graphic Panel Type Instrumentation Sessions November 10, 19 and December 15, 1952. Peoples Gas Light and Coke Company Auditorium, 122 S. Michigan Ave.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS, Conference Room.

CINCINNATI
E. J. Geiser, 3666 Hubble Rd., Cincinnati 24, Ohio Tel. Ja. 5618.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P.M., Engineering Soc. of Cinn.

CLEVELAND
M. M. McMillen, Thompson Products, 2196 Clarkwood Ave., Cleveland, Ohio
Second Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P.M., Cleveland Eng'r Society, 2136 E. 19th St.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth **Wednesday, Dinner at 6:30 P. M.,** Meeting at 8:00 P.M.
November 20, Kelly-Springfield Tire Company, Movie "Principles of Automatic Control".

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
R. A. Hoxie, Basic Service Corp., 14016 Woodrow Wilson, Detroit 6, Mich., Tel: TO-88043
Third Wednesday, Meeting 8:00 P. M., Rackham Memorial Bldg., 100 Farnsworth, Detroit, Mich.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P.M., Siena College, Loudonville, N. Y. Optional Dinner at 6:00 P.M., Circle Inn, Lathams, N. Y.

FOX RIVER VALLEY
John R. Redgrove, Mason-Neilan Regulator Co., 109 S. Appleton St., Appleton, Wis., Tel: 3-7417
First Tuesday, Dinner Meeting 6:30 P.M., Northern Hotel, Green Bay, Wis.

GULF COAST
Harold Placette, 2440 Neches Ave., Port Arthur, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

HOUSTON
A. Costa, 714 East 17th St., Houston 8, Texas.
Last Monday, Meeting at 8:00 P.M., University of Houston Library Building.
Panel Discussion: "Explosion Proof Equipment in Industrial Instrumentation". Moderator W. H. Fortney, Humble Oil & Refining Company.

KANSAS CITY
J. C. Brous, 8827 Maiden Lane, Kansas City 5, Mo. Tel: HI 8556
First Tuesday, Meeting at 7:30 P.M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
A. T. Clinger, Columbia Southern Chemical Corp., P. O. Box 900, Lake Charles, La. Tel. 6-7522
First Wednesday after last Monday, Dinner and regular meetings at McNeese State College

LOUISVILLE
C. M. Bosworth, 5336 Westhall Ave., Louisville, Kentucky. Tel: FR 3494
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Quebec, Tel. Gl 5711
Last Monday of Month, Meeting 8:00 P.M., Mechanics Institute

MUSCLE SHOALS
Atherton Hastings, Tennessee Valley Authority, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW ORLEANS
W. H. Haney, 2927 **Music St., N. O. 22, La.**
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.
December 15, "Students' Nite". Program Chairman, J. Irwin, Long Island Agricultural & Technical Institute.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Dinner at 6:00 P. M., Meeting at 8:00 P. M., N Y. S. Technical Institute, 1685 Elmwood Ave., Buffalo, N. Y.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Robert L. Norman, 351 42 St., Richmond, Calif. Tel: BE 2-0901
Third Monday, Dinner 6:30 P. M., Meeting 8:00 P.M.
Monday, November 10, Luccas Restaurant, 560 Pacific Ave., San Francisco. "Principles and Practice of Electrical Indicating Instruments". Speaker: Henry Berring, Education Director, Western Electrical Instrument Corporation.

NORTHERN INDIANA
J. Baum Beckman, 7145 Wicker Ave., Hammond, Ind. **Second Tuesday, Meeting at 7:30 P.M., Whiting Community Center, Whiting, Ind.**

OAK RIDGE
George Ritscher, 113 Gorgas Lane, Oak Ridge, Tenn. Tel. 5-1084
First Wednesday, Meeting at 7:30 P.M., Ridge Recreation Hall
December 3, Annual Business Meeting and Social Event

ONTARIO
John W. Huether, 311 Southerland Dr., Leaside. Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
George W. Leggett, Box 1526, Phillips Chemical Co., Borger, Texas

PERMIAN BASIN
J. B. Jenkins, 509 South Ave. "C," Kermit, Texas. Tel: 3220
Second Tuesday, Meeting at 7:30 P. M., Gulf Oil Corp. Auditorium or Odessa College.

PHILADELPHIA
R. A. Trenner, Energy Control Co. Rm. 306, 3147 N. Broad St., Philadelphia 32, Pa. Tel: SA 2-7900
Third Wednesday, Meeting at 8:00 P.M., Bellevue-Stratford Hotel.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 5500 Fifth Ave., Pittsburgh 13, Pa. MAflower 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel
November 24, "Instrumentation for Medical Research" by Dr. Moses, Gibson Laboratory.
December 15, Christmas Party

PRESQUE ISLE
Edwin P. Schuwerk, 445½ **Halley St., L. P., Erie, Pa. Tel: 2-3849**
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd., Erie, Pa.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M., American Legion Hall

ROCHESTER
R. C. Schwartz, Jr., Foxboro Co., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Hamilton 1468
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: **EDgewater 2258.**
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., c/o Field Project Manager Ga.,
E. I. du Pont de Nemours and Co., Box 117 Augusta, Ga.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 637, Falfurrias, Texas. Tel: 122-W
First Wednesday. Meeting at 7:30 P.M.

SOUTHERN MICHIGAN
Lyle J. Draper, 2233 Oakland Dr., Kalamazoo, Mich.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M., Chicken Charlie's, Kalamazoo.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

TOLEDO
P. H. Girkins, 418 Waggoner Blvd., Toledo 12, Ohio. Tel: LA 6505
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
James L. Williams, 2237 Bruce St. Kingsport, Tenn. Tel: 2079-L
Fourth Thursday, Civic Auditorium.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
University of Tulsa Campus, Petroleum Bldg.
First Monday, Meeting at 7:30 P.M.,

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P.M., Rm. 353, Coffman Memorial Union, U. of Minn.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium.

WAYNE COUNTY
J. R. McCauley, 18073 Archdale, Detroit 19, Mich. Tel: KE 1-5239.
Third Monday, Meeting at 8:00 P.M., Larson's Cafe, Lincoln Park, Mich.

WILMINGTON
William C. Ruglass, Energy Control Corp., 223 Delaware Trust Bldg.
Wilmington, Del.; Tel: 8-4441
Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

ISA
EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA

1319 *Allegheny Ave.,*
Pittsburgh 33, *Pa.*

ELECTRONIC ENGINEERS, PHYSICISTS AND TECHNICIANS. Are you interested in a permanent, challenging position where you can master a wide variety of problems in the field of instrumentation and special equipment? Would you like to work for a moderate sized, long established, progressive company where your capabilities will be fully recognized financially and professionally? We offer you the opportunity in our Research Department. Send us a statement of your qualifications and experience. We will keep it strictly confidential. Box 749.

DEVELOPMENT ENGINEER. Graduate mechanical or electrical engineer, experienced, for research and development in application of electrical, pneumatic, hydraulic controls and measuring devices to fluid flow and chemical processes. Permanent position in growing industry located in Tuscon, Arizona. Ideal climate and excellent working conditions in new plant. Write giving full details including salary requirements. Box 750.

INSTRUMENT ENGINEERS. Young men interested in power and process instrumentation, helping to make a medium sized company bigger, and living in a Midwestern city with a population of 30,000. Here is an opportunity to make a good salary; to be part of one of the most exciting industries in the U.S.; to work in an established organization where your technical and personal growth is encouraged; to escape the dirt, pressure, impersonality and commuting of the big city, and live in a small town with excellent educational and recreational facilities for yourself and your family. Send personal resume. Box 751.

SALES ENGINEERS. Wanted for large industrial instrument manufacturer. Prefer men with special training in electronics and graduates of recognized engineering colleges. Will consider Mechanical and Chemical Engineers. Fine opportunity for young engineers with sales aptitude to connect with one of the fastest growing instrument companies in the United States. Locations: Cleveland, New York, Chicago and Philadelphia. Box 752.

SCIENTISTS. Intelligent, imaginative, scientists wanted to join the staff of a university-affiliated research laboratory. Permanent positions are open in such fields as the design of small special purpose electronic computers, microwave equipment, and complex electronic instruments. The laboratory is located in Western New York State. Box 753.

A young, aggressive, employee-owned, and leading manufacturer of Controlled Volume Pumps needs the following permanent personnel for an expansion program: MACHINE DESIGNER—SENIOR and JUNIOR. Engineering graduate with 5 to 10 years machine design experience, capable of initiating original designs and detailing for shop manufacture.

INSTRUMENT ENGINEER. Engineering graduate with 5 to 10 years experience in varied application work. Requires a knowledge of electronic, chemical, and mechanical controls to be applied to our product. Will be required to make sketches and shop layouts.
Employee benefits, opportunity, good earnings, profit sharing and pension plan, suburban location, and other benefits. Box 754.

TECHNICAL WRITER. Engineering degree, preferably in Physics or Electronics plus experience in writing technical reports. Salary around $90. Would work closely with scientists in the preparation of technical reports both internal and external. Box 755.

ELECTRICAL ENGINEERS. (Flight Instrumentation) Degree in Electronics plus about 5 years experience in circuit design or instrumentation. Would be responsible for the design and development of flight research instrumentation for performance data and control. A knowledge of "hardware" and an ability to work with same is required. Box 756.

MECHANICAL ENGINEER. (Development) Graduate degree in engineering plus several years experience in development. Fields of specialization might be communication, electronic circuits, dynamic systems, or instrumentation. Would participate in and be responsible for development activities in these fields. Box 757.

MECHANICAL ENGINEER. (Structures) (A.) Degree plus 5 years experience in the field of structures (preferably aircraft). Must be able to perform dynamic, aerodynamic, vibration work and analyze complicated indeterminate structures. (B.) Degree plus 5 years experience in structural and environmental testing and instrumentation. Would be responsible for design, development, instrumentation, and analysis of aircraft structures. (C.) Degree plus some graduate level courses in mathematics. Experience in structural design and testing; experimental and theoretical vibrations; strain gage and dynamic recording equipment is required. Box 758.

MECHANICAL ENGINEER. (Servomechanisms) Degree plus 5 years experience in analysis and development of servos. Box 759.

Philadelphia Fall Symposium

Philadelphia Section will hold their Fall Symposium Wednesday, November 19 at the Bellevue Stratford Hotel. The topic will be "Waste Disposal—Air Pollution."

Registration will start at 8:45 A.M. and the program at 9:25 A.M. The afternoon program will get under way at 2 P.M. and will be followed by a social hour at 4:45 P.M. Election of officers will precede the evening program at 8 P.M.

Measurements in Tractor Design and Development

By R. P. WEHRLE*

THE refinement of design found in the modern tractor has come as the result of many things, consideration of which is not the function of this paper, except for the part played by instrumentation. Although it may not be generally recognized, it is fair to say that without instruments and associated measuring equipment, we could not have such a highly developed product today. Of course, this applies to other products as well.

As Lord Kelvin said the statement that not until you could measure a thing were you able to tell anything about it. Measurements are fundamental to the design and development of a product. They are obtained in the course of test, they allow conclusions to be drawn, and are the basis of further work.

Like many large organizations, International Harvester is divisionalized—that is, made up of separate units, each covering its own product, such as tractors, trucks, implements, refrigerators, and so on. The work in this paper covers that of one of these divisions known as the Farm Tractor Division. This unit is responsible for the design, fabrication, and test development of all farm type tractors. The crawler type come under another division, as do the trucks and other products.

Our instrument section operates under the Plant Engineer of the Farm Tractor Engineering Department. There it can offer its services not only to the test laboratories, but also to advanced engineering and design. To fully understand the merits of measurement in tractor engineering, its place in planning, prior to testing, must be considered. Many special and unusual applications of instruments are employed, particularly in dynamic measurements—a phase that can not be over emphasized.

PLANNING NEW TRACTOR DESIGN

To start a new tractor model, a planning committee made up of representatives from sales, manufacturing, and engineering meet. Specifications of the new tractor are determined. Here previous measurements play an important part in background knowledge. It is always easier to specify new designs if complete technical data is available on present production models.

It may be interesting to some of you to know of a rather unique situation facing all tractor manufacturers, something that is not found in other industries; that is the so-called Nebraska test. This is a laboratory-field test procedure required to be run on a standard production tractor at the University of Nebraska on each different model produced by the company and to be sold in the State of Nebraska.

While this is not a requirement in any other state, the published results are used in competitive sales work over the world. These tractors are not required to meet any particular specifications set up by the State of Nebraska, but the test results and the advertising literature on the product must be in agreement. Thus the tractor manufacturer is prompted to strive for the best performance within the possibilities of reasonable production and customer service.

After the Committee has decided upon specifications, design engineering develops them on paper. Wood and plastic models are made for styling and fit. Portions of the complete design may be tried out. Various ideas that might have merit are put on paper. At any point the Instrument Department may be consulted on possible methods for tests to be made on the forthcoming machine.

WORKING MODELS PRODUCED FOR TESTS

Job lists and blueprints are turned over to the shops for fabrication, where working models are produced. Wood pattern, sheet metal, welding, machining, heat treat, inspection, and assembly shops are included. A materials testing laboratory checks on possible new materials and new uses for old materials. The tractor is the farmer's power plant called upon for many types of work. Therefore, the needed testing facilities are many. The basis of every test stand is the instrumentation and the measurements derived therefrom.

In addition to an engine laboratory, accessory and hydraulic laboratories are also at the disposal of the testing section. Endurance test laboratories provide automatic control and cycling of parts and machines. An extensive field test program is also maintained both at our experimental farm at Hinsdale, Illinois, at Phoenix, Arizona, and on privately owned farms to obtain user reaction, as well as results under various farming conditions.

Perhaps the heart of test work on engine powered machines is the engine laboratory. It has as its central piece of equipment the dynamometer. Most other measurements stem from, or run parallel to, this work. To measure horsepower, a scale for torque, tachometer, and counters for shaft speed are provided. Fuel consumption is measured with trip scales and rotameters, depending upon the fuel used. Temperature measurements are made with electronic potentiometers and thermocouples (see Fig. 1).

The recent arrival on the market of electronic counters with associated

---

*Farm Tractor Engineering Dept., International Harvester Co., Chicago, Ill.

Presented before the Sixth Annual Conference of the Instrument Society of America, at Houston, Texas, Sept. 10-14, 1951.

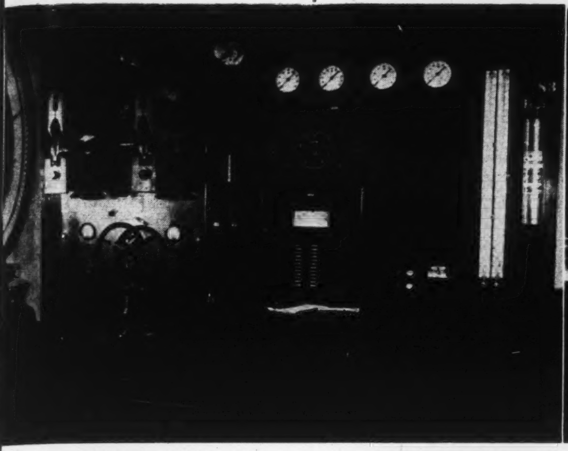


Fig. 1. Engine Dynamometer Control Panel.

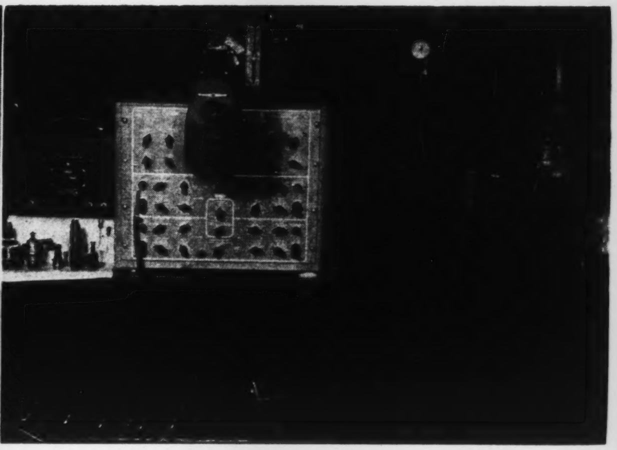


Fig. 2. Dual Beam Oscilloscope and Camera.

gating circuits offers new accuracies. Rotameters for fuel measurements operate well in conjunction with these electronic counters since both provide instantaneous indications, often important. Due to pulsating flow and gravity feed to carburetors, some work was necessary with dynamic pressure measurements in order to obtain satisfactory results with flow meters. Carburetor development is carried out on a flow bench with the aid of flow meters, and burettes.

USE OF OSCILLOSCOPE IN ENGINE TESTING

This basic dynamometer equipment is in constant use for engine testing. As you see, it consists almost entirely of instruments. However, even more useful information can be obtained from dynamic measurements with special instrumentation. To do this, first a basic system of oscillography was needed. A cathode-ray oscilloscope and camera system provides the most versatile piece of equipment. Fig. 2 shows the dual beam oscilloscope and camera in use on an engine.

With this equipment it is possible to take still pictures employing the time base of the oscilloscope, or continuous film graphs employing the film movement as the time axis. Thus any phenomena which can be transduced to an electrical voltage can be recorded. The excellent frequency response of the cathode-ray tube and associated circuits make it ideally suited for dynamic measurements. In addition complete film processing equipment was necessary. Sufficient use of this equipment demanded a separate dark room as part of the instrument facilities.

The application of this oscillograph equipment to measurements in the engine requires electrical transducers and methods of calibration (see Fig. 3). In engine measurements one of the most common dynamic measurements required are pressure-time graphs of the pressures in the combustion chamber. With the cathode-ray oscillographic equipment as a basis, a flat diaphragm type of pressure pickup is used.

Dynamic measurements required for engine study often call for linear displacement. This can be accomplished with the same basic oscillographic equipment. For slow displacement rates, linear potentiometers can be used. At higher rates coils with movable cores are employed. These will indicate valve movement, shaft whip, diaphragm pump movements, and the like. Some of the variable inductance pickups can be operated in oil or water, allowing even greater versatility.

Angular displacement has long been of interest. Torsional vibration and torque are both measured, without the aid of a seismic mass, employing the same basic oscillographic equipment.

Many problems of stress and strain are encountered. For measurements on engines, resistance wire strain gages are employed.

HYDRAULIC TEST STAND

The hydraulic laboratory contains facilities for tests, hydraulic lifts being used quite extensively now for operating farm implements. A typical test stand of this nature employs a motor-driven pump and a remote hydraulic cylinder. The cylinder is rigged to raise an arm carrying dead weight. Fig. 4 illustrates a hydraulic test stand of this nature. Note the air cylinder employed to robot-operate the hydraulic control.

Automatic cycling with an electric timer and control valve is obtained in

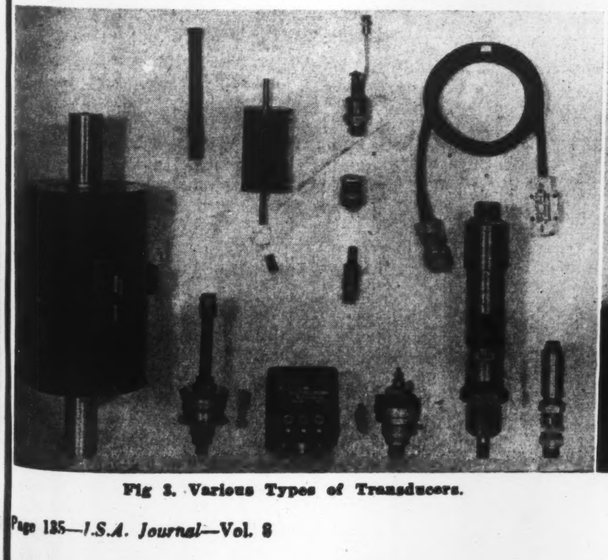


Fig 3. Various Types of Transducers.

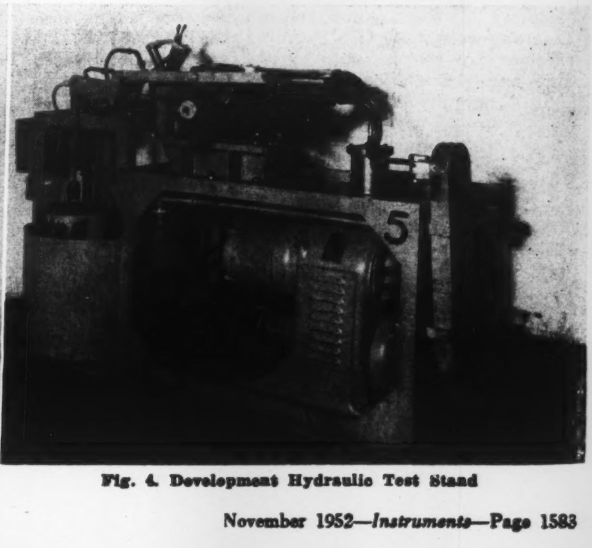


Fig. 4. Development Hydraulic Test Stand

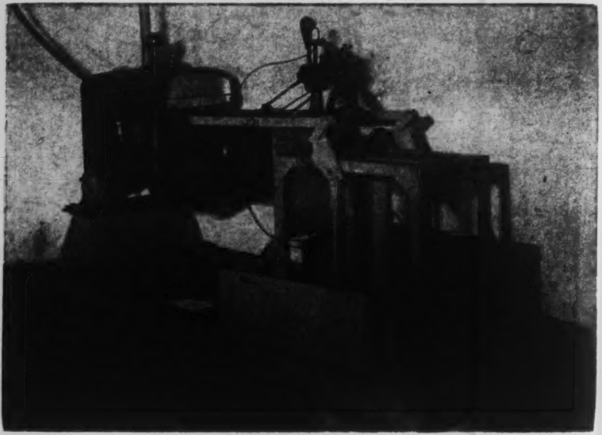


Fig. 5. Endurance Hydraulic Test Stand.

this manner. Other hydraulic tests are made with the entire tractor and engine and a remote cylinder. Endurance tests are made with standard tractor engines to provide the pump power (see Fig. 5). Again the hydraulic lift cylinders are used for loads, and air cylinders for automatic cycling. An electric dynamometer pump test stand is used to check pump delivery. Here oil rotameters designed to cover specific oil grades and temperatures have proved very satisfactory.

For routine pressure measurements, standard hydraulic pressure gages with slotted links are employed. Strain gage pressure cells and the cathode-ray oscillographic equipment supply dynamic pressure information. Continuous film recording has been especially advantageous for phenomena of this nature since it is not repititious

Measurements of force in connection with hydraulic lifts is of great necessity. A strain gage load cell and the standard strain gage indicator give excellent results. The output of the indicator can be fed to the cathode-ray oscillographic equipment for dynamic measurements.

TESTS IN OTHER DEPARTMENTS

The mechanical laboratory tests accessories of the tractor and engine. Tractor cooling tests determine the efficiency of the radiator on the engine and the maximum ambient air temperature at which the tractor will operate. In measuring engine cooling water flows without changing the length of the flow path, a close connected sharp edged orifice has been used quite successfully.

Our Magneto Department, so-called, really covers the testing of both magneto and battery ignition systems, with the various associated units, coils, batteries, switches, spark plugs, relays, magnetos, generators, distributors, as well as starting motors. Many standard and special instruments are used here, with the string and cathode-ray oscilloscopes playing a prominent part.

In field testing, the most prominent unit is the drawbar dynamometer with its instrument control car. Fig. 6 shows a view of the equipment used. The load cell is a rubber diaphragm type transmitting pressure, corresponding to drawbar pull, to a recording pressure gauge, in a closed system. The car uses a truck cab mounted on a tractor chassis.

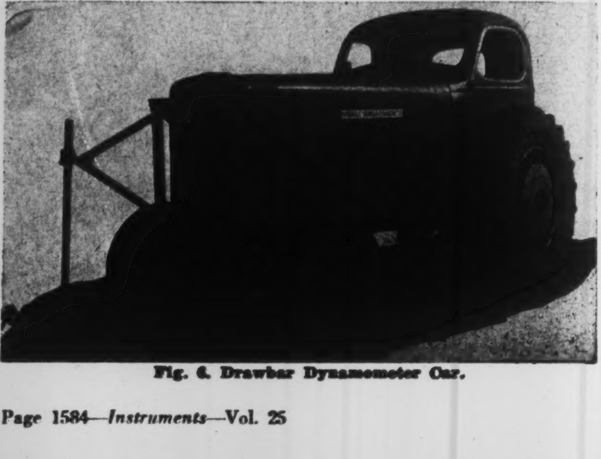


Fig. 6. Drawbar Dynamometer Car.

The engine has been replaced by a water dynamometer operating on a closed system, with the radiator cooling it. Drawbar load on the test tractor is obtained through the drive wheels and transmission to the water brake. Solenoid valves provide load variation. Fig. 7 shows the instrumentation in the cab. Experiments have been made with a strain gage drawbar load pickup with promising success.

Up to this point a rather general description has been given of the test equipment for tractor testing. Should the reader have any questions regarding this work, the author will be glad to try to answer them by correspondence. However, a few specific subjects or applications which offered some problems have been selected for discussion and may be of help to some readers.

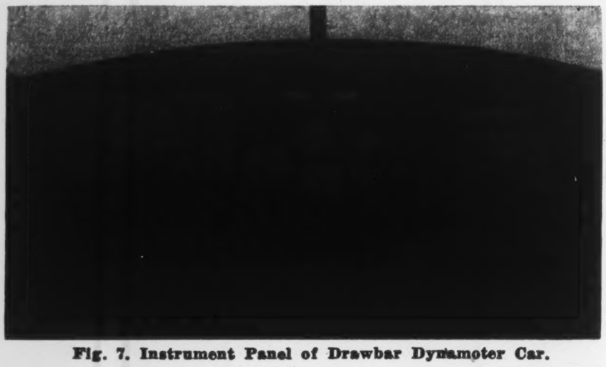


Fig. 7. Instrument Panel of Drawbar Dynamoter Car.

OSCILLOGRAPHIC EQUIPMENT

Throughout this paper, reference is made to oscillographic equipment for dynamic measurements. This equipment provides graphs of various functions with respect to time. As mentioned, a dual beam cathode-ray oscilloscope is the heart of this equipment. A camera made especially for recording oscilloscope curves provides a permanent record.

This type of equipment was selected for its versatility, frequency response, simplicity and ruggedness. It is versatile in that any mechanical phenomena that can be transduced to an emf can be recorded. Its wide frequency response supplements its aptness to all phenomena of low or high repetition rates.

Here it is well to note that although a function may occur once per engine revolution—say, 1200 times a minute or 20 cps—the maximum frequency response of the recording system may have to be much higher because of the steepness of the wave fronts encountered. Usually for practical analysis the rate of rise or decline of the wave fronts gives a reasonably accurate indication of the maximum frequencies contained in the wave.

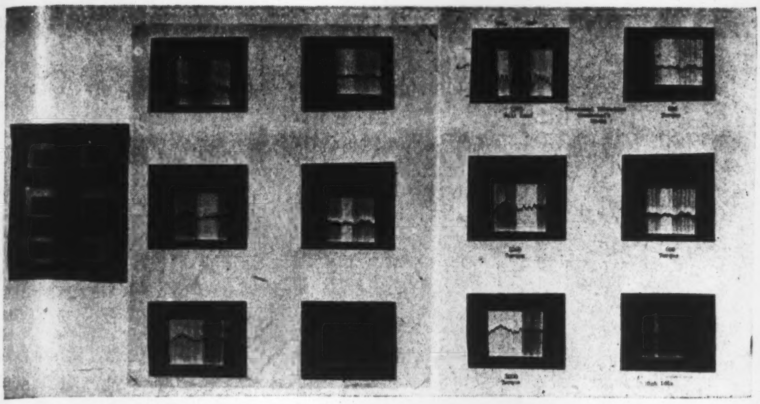


Fig. 8. Oscillogram Reproduction: Left to Right, 35 mm Negative, 8 by 10 Enlarged Negative, and 8 by 10 Whiteprint Transparency.

Some of the requirements of an oscilloscope for use in mechanical measurements are low sweep frequencies, 1 to 30,000 cps; single sweep features; intensity modulation; acceleration voltage of at least 3000 volts; and low as well as high amplifier frequency response, 0 to 200,000 cps. Indentical horizontal and vertical amplifiers and access to the deflection plates are also desirable. Of course, it must have the general qualities of good electronic equipment as to stable design, rugged construction, and capability of operation above normal room temperatures.

RECORDING CAMERA

The recording camera takes still or continuous film pictures. A film size of 35 mm is very practical. Standard spools and film speeds are used. Either Eastman Super XX, Linograph pan, or equivalent, is very suitable. Oscillograms of repetitious functions are made with the sweep circuit of the oscilliscope as a time base. The shutter speed must be at least as long as the time of one cycle.

If the phenomena is not repetitious, continuous film recordings are made. In this case the film provides the time base. Film speeds depend on details required and total time involved. The camera used for the work in this paper has a + f 1.5 lens and film movement speeds from one inch per minute to 60 inches per second.

To make full use of this oscillographic equipment a film editor and splicer are used. Film projection may be employed for analysis. The final sections of the film are spliced into 4 by 5 inch negatives (see Fig. 8). As necessary, these are enlarged by the photographic department to 8 by 10 negatives. These 8 by 10 negatives are run through a whiteprint machine to make transparencies.

These transparencies have the titling and calibration or other information added to them. Then by again running them through the whiteprint machine, as many prints as is required can be made. This is particularly useful in an organization where reports are given wide circulation. Also they are very convenient for compiling the information in a condensed form for future reference. Contact prints from the 35 mm negatives and reproductions can be made by the same process, if desired.

USE OF OSCILLOSCOPE

An application of this dynamic equipment to measurements of a mechanical nature is given in the following case. Instantaneous flow records of the oil operating a hydraulic lift cylinder were desired. This information would indicate the maximum demand of the lift on the pump. It was decided that it could most easily be accomplished by a displacement-time curve of the piston movement. Knowing the cylinder cross-sectional area, volume versus time could be obtained from the curve and differential

$$\frac{(\,d\,v\,)}{d\,t}$$

of the latter curve would be the instantaneous flow at time t.

To obtain the desired curve, a linear potentiometer was mounted on the cylinder (see Fig. 9). Thus a resistance value proportional to cylinder position was obtained. A fixed battery voltage was applied across the total potentiometer. Then the voltage from the movable tap to one side of the resistor indicates cylinder position. Since the total time for a full cycle was known to be several seconds, this voltage is applied to the horizontal deflection plates and a continuous film recording was made.

A timing wave was added to accurately mark the film speed. Fig. 10 shows a typical section of oscillogram. The rise time, slope, piston velocity, and peak pump delivery rates can be calculated from the curve. This information is most easily secured by graphical methods. Smoothness of operation can be seen from the curve. Such a record provides permanent data which can be used for future model specifications.

PRESSURE MEASUREMENT WITH TRANSDUCER

Measurements involving pressure are common in tractor engineering. For this purpose a pressure transducer of the flat diaphragm type is employed. Diaphragm deflection causes a change in capacity which modulates a 100,000 cps carrier. The modulated wave is rectified and fed directly to the oscilloscope.

The transducer in this case has an excellent frequency response since the resonant frequency of the diaphragm is relatively high. The diaphragms are changeable to various thicknesses to allow operation of the same pickup over a wide range of pressures. Calibration of the pressure axis can be obtained by static methods since the carrier affords a zero frequency response.

For many uses a balanced pressure pickup supplies an absolute calibration. The two pickups can be used in

Fig. 9. Hydraulic Cylinder with Displacement Pickup, Linear Potentiometer.

Fig. 10. Curve of Hydraulic Cylinder Stroke vs Time. Timing Wave 20 cps. Upper trace, 2¼-inch piston with an 8-inch stroke; Lower trace, 3¼-inch piston with an 8-inch stroke.

a Y-fitting at the point of pressure sampling. The signal from this pickup intensely modulates the cathode-ray beam to indicate when the pressure exceeds the known backing pressure on the balanced pressure pickup.

A common application of this pickup is for engine indicator cards. In order to calibrate the time axis and relate it to top-dead-center on the engine, markers are incorporated. The five degree markers are generated from a 72-tooth gear and a magnetic pickup. Top-dead-center and synchronizing pulses are obtained in a similar manner. Pulse shaper and mixer circuits combine the outputs for presentation on the oscilloscope.

Fig. 11 shows a typical pressure-time curve of the main chamber of a diesel engine. On the other beam a similar pressure pickup indicates the pressure-time curve at the injector nozzle. Thus close pressures at the two points can be shown simultaneously and recorded superimposed or not, as desired.

In Fig. 12 another example of a pressure-time curve is recorded. Here the pressures in the primary pump are compared to the pressures in the distributor block. The curve depicts the pressure during the charging time of one cylinder. On a six cylinder, four cycle engine, three such curves exist per crankshaft revolution.

OTHER USES OF OSCILLOSCOPE

Another instance of pressure-time oscillography is shown in Fig. 13. This is two parts of an oscillogram of an engine starting test. Here a continuous film of an engine indicator card is photographed. The engine is motored and the throttle opened. Actual pressure-time curves are taken of each revolution. Each miss is recorded; the gradual ignition advance and engine acceleration is also indicated. Thus a record of the cold starting action of the engine system is obtained.

An example of a linear displacement measurement is shown in Fig. 14. The pickup consists of a coil mounted at the end of a rod. Metal movement at its tip will cause a change in inductance. A 50 kc carrier is modulated, rectified, and presented to the oscilloscope. The oscillogram is taken from a gear driving the hydraulic pump shaft.

The large continuous ripple is due to the gear being slightly off-center. The sharp peaks are the teeth as they pass the pickup. The narrow slot in the curve is caused by a tooth that was cut 0.005 inches lower than the adjacent teeth. This serves as a calibration mark.

The upper curve shows the deflection when the pump is loaded as indicated by the general depression of the curve. The lower curve shows the deflection upon stopping the shaft. The individual teeth are clearly visable as they pass. The tooth outline is not true to shape but the total deflection of the shaft and gear is accurate from the general level of the curve.

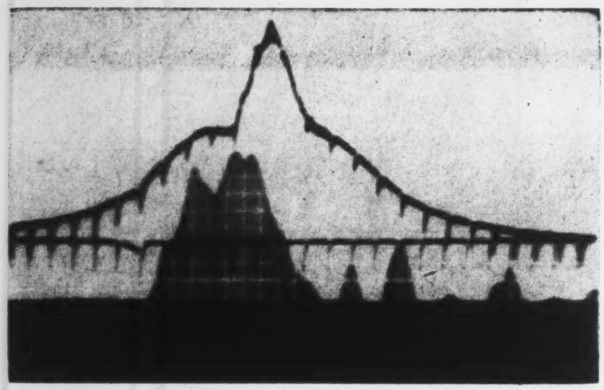


Fig. 11. Diesel Engine Pressure Time Card. Upper curve main chamber, lower injection pump line.

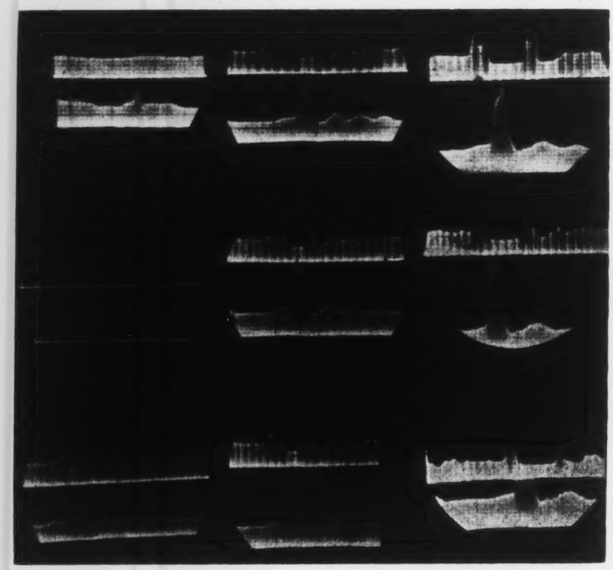


Fig. 12. Series of Injection Pump Pressure Diagrams.

Fig. 13. Engine Starting Test — Two sections

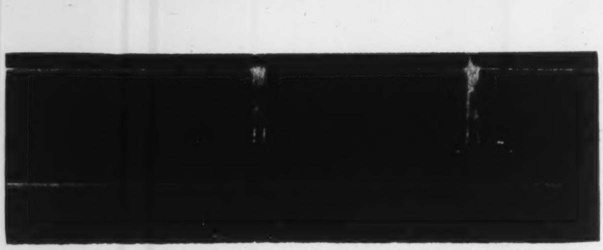


Fig. 14. Gear Deflection Diagram — Two sections.

Research vs Industrial Instrumentation

By DELMAS C. LITTLE*

It would be foolish for any one person to attempt, from personal experience, to make a complete comparison between the fields of research instrumentation and industrial instrumentation. Few men are familiar with all the components that go to make up either bracket. Since the majority of instrument men are familiar with the industrial branch, this picture will be presented from the research angle, using the differences and similarities that occur between a physiological research laboratory and industrial instrumentation in general. A physiological research laboratory deals with the animal servomechanism and why it works as well as how it reacts to various normal and abnormal stresses such as heat, cold, light, radiation and fatigue.

DIFFERENCES AND SIMILARITIES

It may be thought that such a comparison is not legitimate; but all research follows the same general lines and deals with the various natural phenomena and their whys. This requires an enormous number of measurements, carried on until a picture emerges; then an infinitude of measurements to confirm the picture. In industry the value to be desired is generally known and the instrument man is concerned with ways to make the process conform.

Even this basic difference is not absolute, for often the industrial instrument man is satisfied to make measurements, leaving it to some other department to utilize the values obtained. In contrast the research instrument man must control the conditions under which his measurements are made.

In the Army Medical Service Field Research Laboratory at Fort Knox the same fields of instrumentation are to be met that may occur in industry. Body temperatures must be taken, blood pressures must be determined, the rates of flow measured. Energy measurements are made in determining metabolic rates. Mechanical measurements must be made in determining body motion. Gas analyses must be made on inhaled and exhaled air.

Sometimes these measurements are made by the batch method and sometimes they are continuous. Figure 1 is a picture of the panel used in the cold environment research studies at the Laboratory at Fort Knox. On this panel are instruments for measuring temperature, pressure, flow, energy, displacement, and gas analysis. Most of the instruments are readily identifiable by industrial instrument men and will be referred to in more detail later.

TEMPERATURE MEASUREMENTS

Probably the most frequent measurement to be made in the laboratory is one of temperature. The chemistry sections deal mostly with batch operations and, as such, use the common glass thermometer in all its various forms, including the mercury regulator for bath temperature control. Since chemistry laboratories are so very similar nothing more need be said about this field.

The mercury-bulb recorder is used in the haemotology and central nervous system sections for recording environmental temperatures. In these laboratories records must be kept 24 hours a day and seven days a week. In the haemotology lab the temperature range is from minus 40° F to plus 120° F, and in the central nervous system lab the range is from minus 22° F to plus 122° F. The mercury-bulb recorder was selected for these laboratories since the temperature limits were the critical values rather than instantaneous values and this type of recorder will give temperature limits even in case of chart drive power failure.

Where more accurate measurements are necessary and time of measurement must be closely known, thermocouples are used. Since the temperature range lies between minus 70° F and plus 150° F, copper-constantan couples are the most suitable and are used throughout the laboratory. It is at this point that the idiosyncrasies of physiological research appear. In this temperature range the ordinary problem of a protective-well is missing, but another protective problem comes to the fore. How can a couple be protected that is attached to the under side of the great toe of a walking man and still indicate the correct tempeature of the skin at that point?

Fig. 1 Cold Room Instrument Panel

In order to determine true surface temperatures without inhibiting heat radiation or absorption, the couple must be used without any protection and must have a minimum of mass to follow rapid changes of temperature. This imposes a serious limitation on the size of the couple. At the same time the test-subject must have complete freedom of movement. To meet these conditions a wire composed of seven strands of No. 36 gauge wire is used for the couples and harness; seven strands of No. 28 gauge wire, for flexible extension leads; and solid No. 20 gauge for fixed extensions.

As may be expected, there is a high mortality of such couples. Because of the fineness of the strands, the individual conductors break quite easily, necessitating a solid insulation to hold the broken ends in and not allow shorting of the couple. This brings up another problem at low temperatures—maintaining flexibility at minus 70° F. Rubber becomes quite brittle at this temperature, and the other ordinary solid insulators are far too stiff.

As a compromise three mills of nylon are used on each conductor, with two mills over-all on the pair. This gives a small wire with a fair degree of flexibility but causes a high breakage of individual strands.

CONNECTION OF COUPLES TO INSTRUMENT

Another problem to be met in the use of thermocouples at these temperatures is the connection between the couple and the measuring instrument. This, at first glance, may seem a simple problem, but when all angles are considered it becomes quite complicated. First, to maintain accuracy, the measuring instrument cannot be used in the cold room, necessitating bringing the leads out of the room. Second, the leads must be able to be quickly connected and disconnected.

It is as important to know the rate of cooling as it is to know the temperature under static conditions, and occasionally it is necessary to bring a man out in a hurry when some part of his protection fails. The solution is, of course, some type of a connector—one designed for thermocouples, but this in itself is a problem. A man may have as many as 16 couples attached to the various parts of his body. All the commercially available multiple connectors had two drawbacks: weight and lack of ease of operation.

---

*Army Medical Service Field Research Laboratory, Fort Knox, Ky.

Presented at the Sixth Annual Conference of the Instrument Society of America, at Houston, Texas, Sept. 10-14, 1951.

Since as mentioned before, there is such a high mortality of thermocouples, they have leads just long enough to be brought out of the clothing at some convenient point, usually the neck. From here, heavier flexible leads run to a connector panel on the wall and solid leads are carried out to the recorder. Such an arrangement necessitates connectors at the man, which means that they can not be too heavy and, at the same time, they must be simple and easy to operate. The observers will often have on as many as three pairs of gloves, and cannot perform delicate manipulations.

A simple eight-contact electronic type connector is used with no fastening other than the contact pressure. The manufacturer supplies these with Advance Metal contacts replacing the regular contacts in the odd numbered positions. This arrangement is quite satisfactory, producing a thermal emf of only three microvolts with a temperature difference of 100° C across the two halves of the connector. The standard connector produces about 150 microvolts under the same conditions.

THERMOCOUPLE TERMINAL PANEL AND RECORDERS

The wall panel introduces a problem of its own. As long as the room is cold, no trouble is encountered, but after about ten days of operation the room must be defrosted and then the trouble begins—condensation. The wall terminal panel was finally enclosed in a box (Fig. 2) with a gasketed door and the fixed-lead conduit brought into the box. Within the box, behind the connection panel, is located a 200-watt heater with two thermostats, one set at 70° F to limit the temperature and the other, reverse acting, set at 25° F to cut the heater out when the room is in operation and the door is open. The conduit must be filled with wax where it runs through the room wall to prevent condensation within the conduit from the outside air.

The measuring instruments used are three commercial recording potentiometers—two with a range of from minus 60° C to plus 40° C and one, from minus 10° C to plus 40° C, all multi-point instruments. The instrument with the 50° C span is a 16-point, high speed recorder with an accuracy of 0.2° C and is used for most of the skin temperature recordings. One of the others is a slow-speed 12-point recorder with an accuracy of 0.25° C for measuring ambient temperatures.

The third instrument is a flight-test recorder with a total of 144 points, and is used when a large number of temperatures are to be taken. In order to have a basis for comparison, a second room is used that is maintained at 72° F. In this room is located a terminal panel similar to that in the cold room. Both the 12- and 16-point instruments are terminated on both panels with the flight test recorder being divided one-half to each panel, giving 100 points available at each panel.

For high accuracy measurements of individual temperatures throughout the entire laboratory, L & N Type K potentiometers are used, but the recording potentiometer has been found accurate enough for almost all work. As temperature standards, two Bureau of Standards calibrated platinum resistance thermometers and a Mueller Bridge are used. These are used only for the calibration of individual thermocouples for special measurements, the wire as supplied being accurate enough for ordinary work.

PRESSURE MEASUREMENTS

One of the instruments always associated with the medical profession by the layman is the sphygmomanometer, for measuring blood pressure. However, for research purposes the sphygmomanometer does not tell enough and is not sufficiently accurate. Actual pressures must be taken in various blood vessels, not only of the average pressure, but also of instantaneous pressure changes throughout the heart-beat cycle.

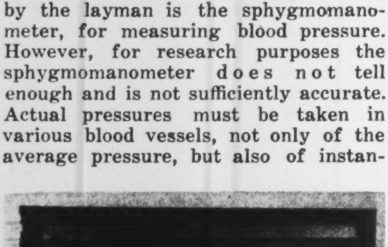


Fig. 2 Cold Room Thermocouple Terminal Panel

The average heart rate is around 72 per minute, but there are components within the cycle up to 100 cps so that it is readily apparent that the ordinary methods of pressure measurement will not suffice. Several methods have been developed each with its own advantages and disadvantages. Two of these are of interest to the industrial instrument man, one because it is familiar and the other because it is unique.

The first is the strain gauge manometer and is almost identical with the unit used for pressure measurements by the automotive laboratories. Because of the comparatively low pressures, 0-10 psi involved, its sensitivity is poor and its stability leaves much to be desired, but is by far the simplest to use. The pressure unit terminates in a No. 20 or No. 21 hypodermic needle that is inserted in a blood vessel against the blood flow and can be used with very little physical discomfort.

GREGG MANOMETER

The other blood pressure instrument is the *Gregg manometer* (Fig. 3) and is unique in that it is not electrical. A rubber or mica membrane is fastened across the end of the barrel. The barrel has a 0.125-inch hole through it, giving a pressure area of about 0.0044 square in. A very small mirror is cemented, off-center, to the membrane.

The mirror reflects a light beam onto a recording camera, so that it is possible, by changing the mirror to camera distance, to adjust the amplitude of the record to the particular experiment. Lead tubing is used for connection between the blood vessel and the manometer to limit, as much as possible, the elasticity of the system to the membrane. The system is filled with a sterile saline solution and has all bubbles very carefully excluded to improve the high frequency response.

At first thought it would seem that a larger diaphragm, with greater sensitivity, would be desirable, as it would, but it would introduce a difficulty that far outweighs the gain. It goes without saying that the smaller the diaphragm, the smaller the flow of fluid with a change of pressure. By holding the flow of blood into and out of the pressure-pick-up needle to a minimum, the possibility of the bloodclotting in the small bore of the needle is held to a minimum.

OTHER PRESSURE GAUGE APPLICATIONS

The ordinary Bourdon pressure gauge may be found in use in the laboratory also; as a receiver for a remote control valve, although the valve bears little resemblance to any type of industrial valve. In studying the heat loss of a hand or foot or arm or leg it is necessary to know, among other things, the amount of heat being supplied by the blood. The easiest way to determine this is to stop the blood flow to and from the member by a tourniquet.

Since the member is usually enclosed in several layers of clothing, some of which are quite heavy, a tourniquet similar to that used in the sphygmomanometer is applied, but instead of using a small hand bulb to pump in the air, pressure is applied from the laboratory air system. A receiver gauge is used to show the pressure in the cuff, operated by a separate line from that used to supply the air to the cuff.

A rather unique application of an aneroid type gauge was worked out by a physicist in the cold room section of the laboratory. In order to determine metabolic rates from exchange of respiratory gases the test subjects in the cold room breathe into large air-tight bags (Douglas bags). When the bags are full, the expired air they contain is transferred by valves to a pumping system and pumped through gas analyzers and gas meters.

In order to check for leaks in the system, periodically the outlet from the meters is connected to the intake system and the pump started. An aneroid gauge with a range of 250 mm of water, is arranged in the connecting line and any leak in the system will show as a change in pressure on the gauge; an increase in pressure showing a leak on the intake side of the pump, and a decrease in pressure indicating a leak on the outlet side of the pump. For small leaks the rate of change of the pressure is an indication of the magnitude of the leak.

FLOW MEASUREMENT

The question of fluid and gas flow must be met in physiological research just as they must be met in industry, and much the same type of equipment is used. In measuring the sweat rate of a man, dry-air is circulated over the nude man, or over a portion of the skin area. The moisture content of the air is then determined and the volume of air is determined by integrating the rate of flow as measured by an orifice flow meter. Actually the flow is held as constant as possible by maintaining the pressure drop across the orifice plate constant. This is comparatively easy to do by using a closed system and drying the air by calcium chloride.

The rotameter is also used for measuring flow rates, both indicating and recording. Commercial rotameters are used together with a differential pressure regulator to get the very low flows required by the gas analyzers. The recording manometer, however, is special, having been developed by Shipley of the Lilly laboratories to measure blood flow in the coronary vessels of the dog.

Fig. 4 is a sketch of the manometer together with a typical calibration curve. The body of the rotameter is made of acrylic plastic and can be taken apart for cleaning and sterilizing. The float is of the disc type which cuts the viscosity error to a minimum. A rod extends up from the float and carries a slug of iron. The coil is taper wound so that the position of the slug determines the inductance of the coil.

The coil forms one arm of an A-C bridge that is in balance at "no flow" through the rotameter. As blood flows through the rotameter the bridge is unbalanced, according to the rate of flow. The unbalanced current is rectiled and fed to an optical galvanometer and recorded on the same camera as the pressures from the Gregg manometer. A typical setup is shown in Fig. 5.

Mention should be made of an air flow instrumentation problem that is not in use as yet but will be very shortly. In studying the heat loss of a man it is necessary to know the loss contributed by air movement within the clothing or at a particular spot on the skin surface. The Hastings Instrument Company is developing a modification of their precision thermocouple anemometer for this particular application. The pick-up unit has a diameter of ¼ inch and provides not only air flow data but skin and ambient temperatures as well.

ENERGY MEASUREMENTS

If there is any one field where the research laboratory utilizes a wider range of instruments than industry, it is that of energy measurements and the physiological research lab is no exception. Even that commonest of industrial energy instruments, the "house electric meter" or integrating watt-hour meter is used in the psychology laboratory although not as an energy meter, but as an integrator for deviation measurements in certain tracking experiments.

Of course the most important energy measurement is that of metabolic rate. Metabolic rate measurements are to the human body what efficiency determinations are to a power plant. It is easy to calculate that so many pounds of coal of such and such a Btu value produced so many kilowatts of power. So may a person be fed so many grams of food containing a given number of calories of energy and perform so many centimeter-grams of work.

But what of the Btu that didn't appear as energy equivalent and what of the calories that didn't appear as work performed? Just as flue-gas analyses are made on the boiler so must exhaled air be analyzed for oxygen and CO_2 content. And as the auxiliary equipment power consumption must be known in a power plant so must the energy used to maintain body temperature be known as well as that for the various body functions.

No one instrument measures all these values in a power plant nor can any one instrument do it for the human body. The various means of measurement have been taken up or will be taken up under their proper classification.

USE OF RADIATION PYROMETER

However energy measurements are made, as such, in a physiological laboratory, some are of a minuteness as to seem non-existant to the industrial instrument man. The radiation pyrometer is used industrially to determine temperatures not practically determinable by other means. So may it be used to measure skin temperature in man. It must be remembered, however, that the radiometer measures the instantaneous rate at which it receives energy so that by integrating the output of the instrument over a period of time the energy loss, through radiation, of the area under consideration may be determined. Under clothing the loss is quite low but for exposed skin it is quite appreciable, and in hot climates, very important.

The fact that the body is receiving radiation as well as emitting it, must also be borne in mind. Practically everyone, at some time in his life, has been sunburned. Some burn quite easily, while others burn but very little. Just what wave length of radiation causes the burn, how much energy is in that wave length and how does skin

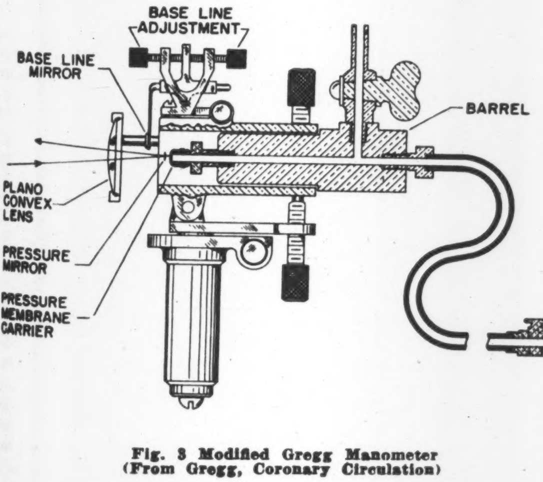


Fig. 3 Modified Gregg Manometer (From Gregg, Coronary Circulation)

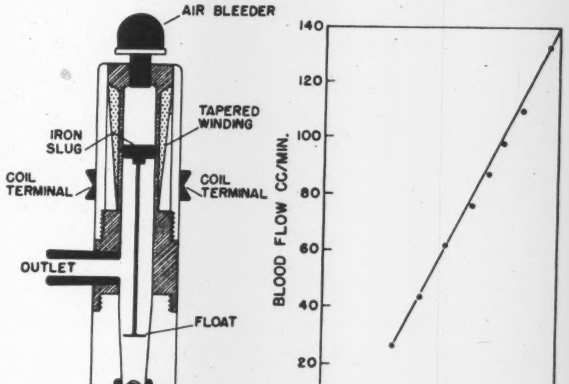


Fig. 4. Shipley Rotameter (Courtesy D. E. Gregg)

coloration protect against the burn are problems of the biophysics laboratory.

The various burns may be produced by exposure to radiant energy but to be of practical value the wave length (whether it be infrared, visible, or ultraviolet) must be known, and equally important the energy level or intensity of that wave length must be known. The spectrograph is used to determine the wave length and the thermopile the energy. In some laboratories the bolometer has been used for the energy measurement and in others the photocell, but the response of the multiple element thermocouple has been found more uniform throughout the complete spectrum, thus indicating its use for this work even though its output is lower than either of the others in their particular ranges.

The standard thermopile used in our laboratory has an output of 0.293 volts per watt per square inch of incident energy. With an input range up to 1420 micro-watts per square inch an output of up to 10 micro-volts may be expected, a quite small quantity indeed and extreme care and precision must be used in measuring it.

MEASURING ATOMIC ENERGY

In this so-called "Atomic Age" everyone is interested in the atomic bomb and its effects. The Army Medical Service is no exception. By far the greatest percentage of casualties have been shown to be burns—technically, thermal burns, the result of the intense heat and light of the explosion. However, a fair percentage of the casualties may result from "radiation burns" from the gamma radiation of the fission itself. These also must be studied, frequencies determined, energy levels established and actual damage evaluated.

At the same time the possibility of protective measures must be investigated. Here, however, because of the greater power of penetration of the radiation, the damage lies mostly below the skin. Since the gamma wave length lies within the x-ray range and is identical with it, x-rays are used as an experimental energy source, for they can be much more easily controlled both for wave length and intensity (incidentally, also much cheaper).

Here again must energy levels be measured. For the purpose the "r" meter or ionization chamber is used, the energy being measured in "r's" or roentgen units. The Geiger-Mueller tube is of little value in the gamma range at the energy levels used.

The Geiger-Mueller tube is used, however, in radiation effect work, because in determining the effect of alpha and beta radiation, radioactive materials must be used and the intensity measured. At first thought one would say that the Geiger-Mueller tube is not an energy measuring instrument. It should be remembered that a particular tube responds to a certain energy-level band, those particles of lower energy not being able to penetrate and those of higher level passing on through with very few being stopped.

How many have ridden in tanks? Or stood and waited for one or more to roar by? Noise? One of the problems of the psychology laboratory is the measurement of the intensity or energy level of this noise and to determine how much it contributes to the fatigue of the crew members. The automotive industry, to a limited extent, is interested in the noise level within the car from a comfort standpoint and recently, one farm tractor company has considered noise investigation.

MECHANICAL MEASUREMENTS

Not only must the noise level in tanks be measured but also the vibration, for these vibrations are in reality the very low frequency noises. This involves displacement measurements in micro-inches but at a velocity that the strain gauge is not able to follow satisfactorily. Various vibration pickups are used and the result amplified to give a usable output. One of the industrial research laboratories should be announcing in the near future a method of measuring the displacement as a displacement and not as the result of the integration of a velocity.

In the oft-referred-to metabolism studies, displacement measurements are of extreme interest. Chest girth changes are used as an indication of the rate of respiratory exchange, and to some extent as a rough indication of the volume of air inspired and exhaled. This requires calibration of the measuring instrument, a *pneumograph*, against the individual.

The calibration may be accomplished at low speeds and then the pneumograph used at higher rates as on a walking or running man. Various pneumographs have been developed but none with too high a degree of success under all conditions. The instrument in most common use is a rubber bellows that expands and collapses with change in girth — the change of volume actuating a small spirometer and the resulting motion registered on a recording kymograph.

The loading on the subject of this system is very low but the equipment is extremely temperature-sensitive and is of practically no use at very high or very low temperatures. Various types of electrical resistance instruments have been tried with various degrees of success but all are too bulky to be worn under clothing. Two new types are at present under trial but it is far too early to report them as satisfactory.

ANALYSIS INSTRUMENTATION

It goes without saying that analysis instrumentation is of extreme importance in a research laboratory but few realize how much of this instrumentation is common to both fields. Yet this is only to be expected because most of it evolved in the research laboratory and graduated to industry as industry demanded more and better measurement and control. In the chemistry laboratory may be found pH meters and titration indicators, that, if not identical with, at least are the forerunners of the industrial equipment. For the most part, the industrial equipment has an accuracy as great as the laboratory equipment. Indeed, if the laboratory could run on a continuous basis, the industrial equipment would be used since it is much easier to operate and is much less liable to human error.

In the panel shown in Fig. 1, two pieces of industrial analysis equipment occupy a third of the total space. These are the oxygen and CO_2 analyzers. The oxygen analyzer operates on the magnetic susceptance of oxygen and was developed by Beckman. It has a range of 0 to 25 per cent and an accuracy of one per cent of full scale. For CO_2 the Baird infrared absorption gas analyzer is used, permanently set for CO_2.

Both of these instruments have a latent time of approximately one minute but since they are used for quite large samples of air, 100 to 150 liters, this is not too great a disadvantage.

In the sweat rate problem mentioned before, an L & N portable selective infrared gas analyzer is modified to measure the water content of the air.

The infrared absorption principle is also used in an infrared spectro-photometer. In this, as the name implies, the absorption is measured in a continuously changing narrow wave-band through the range from 2 to 16 microns wave length. This may be an absolute measurement of a sample or may be a comparison with a standard sample to show variations from that sample. The infrared spectrophotometer may be used on liquid and solid samples as well as gas samples.

The visible light range spectrophotometer is in use also. The recording spectrophotometer built by General Electric Company is used to measure the reflectance from various pigmented or burned skins; the reflectance from various chemical compounds, etc.

AUTOMATIC CONTROL APPLICATIONS

It must not be thought that measurement instrumentation is all that is required in research. Control equipment must be used, too, but not to the extent that it is in industry. In the metabolism studies a commercial vacuum switch is used to stop the pump when the air bags have been evacuated to the proper point, thus assuring a constant residual volume in the bags. The air pressure applied to the tourniquets used in the same project is controlled by a positioning regulator.

It is quite common to see valves almost as tall as a man on exhibition at the conferences. Fig. 6 is an assembly drawing of a control valve

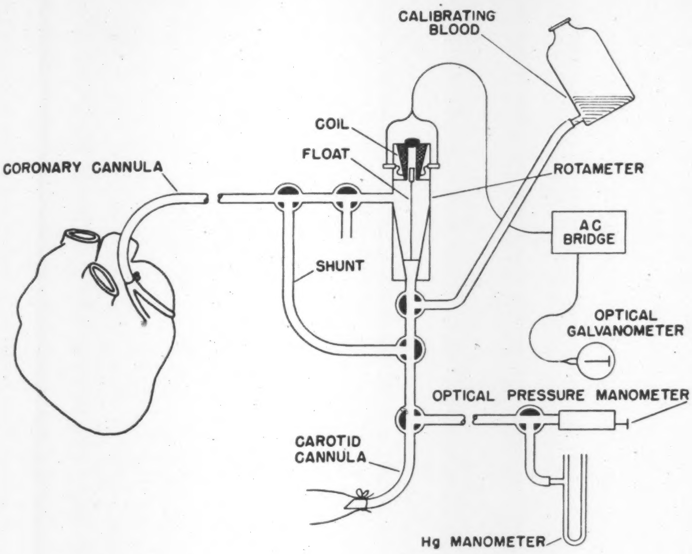


Fig. 5 Schematic Drawing of Arrangement of Apparatus for Measuring Coronary Flow. (Courtesy D. E. Gregg)

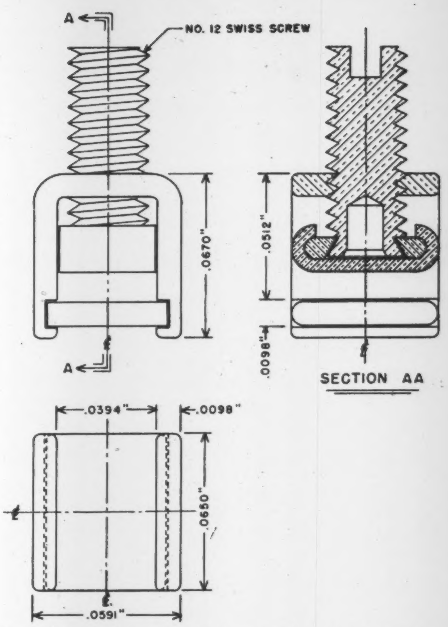


Fig. 6 Goldblatt Clamp as Modified by Gregg & Monnell. (Courtesy D. E. Gregg)

about 30 of which were constructed by the instrument maker in the Medical Research Laboratory at Fort Knox. It is a modified version of the Goldblatt Clamp which was about eight times as large. It is constructed entirely of coin silver and, in spite of its size, its screw-thread is semi-precision.

In spite of its name "clamp," it is not a clamp but a control valve; being used to regulate the blood flow to the kidney of a white rat weighing about one-half pound. When the flow is reduced to the proper point the rat develops hypertension, or high blood pressure, and can be used in studies dealing with this condition.

Fig. 7 is a picture of a fully automatic air-conditioning problem that was dealt with by the instrument section of the laboratory as a project of its own. It will come as quite a surprise to most people that this is a baby incubator and that the Army hospitals have 500 of these units in addition to various other makes. Two things must be borne in mind, however: first, that the Army is pledged to furnish, as far as is possible, medical attention to the dependents of Army personnel; and second, the Army now has the highest percentage of married personnel that it has ever had in its history. The Fort Knox Hospital alone had over 1000 deliveries in 1950, so that the need of baby incubators is understandable.

This particular unit was not entirely satisfactory as purchased and one unit was turned over to the instrument section to see what could be done to improve it. When finally returned, the unit could hold a temperature to plus or minus one-third of one degree Fahrenheit in the range of 60° to 105° and the relative humidity to plus or minus 2½ per cent between 50 and 95 per cent. It is possible that the unit could have held the relative humidity closer, but there were moisture problems beyond the control of the unit.

CONCLUSION

This has been by no means a complete survey of instrumentation in a physiological research laboratory, but only typical examples. For the most part the work of an instrument man in a research lab is quite similar to that of the industrial instrument man and is mostly routine. For the most part new instrumentation lies in recommending a particular piece of commercial equipment and making the modifications that may sometimes be necessary. The instrument man's hardest problem is finding the time to keep track of all the equipment that is available, and its capabilities and limitation. The real fascination of the work does lie in the few special design and construction problems that fall to his lot, but the instrument engineer in any large industrial plant probably has even more of this to do.

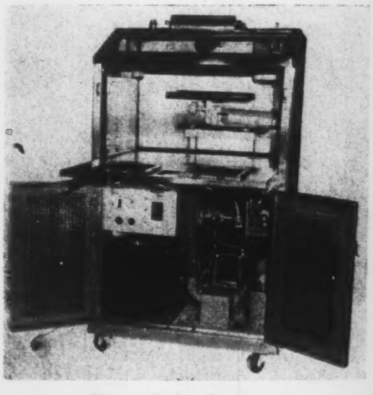


Fig. 7 Baby Incubator

Second Edition Now Available

Mechanical Measurements
by Electrical Methods

Serialized in *Instruments* under the title
"Electric Gaging Methods"
By HOWARD C. ROBERTS

ORDER THIS UNIQUE BOOK NOW

$4.00 postpaid

Remittance must accompany order

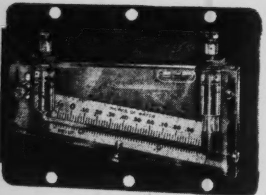
INSTRUMENTS PUBLISHING CO.

921 Ridge Avenue, Pittsburgh 12, Pennsylvania

DWYER

Unbreakable, Clear Acrylic

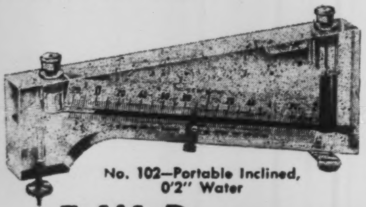
DRAFT GAGES



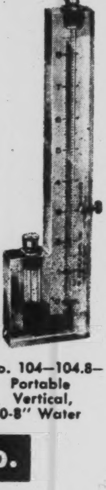
No. 200—Stationary Inclined, 0'1" Water

Portable and Stationary

The unique crystal clear, solid block bodies of these instruments are a decided advantage in making accurate readings — light enters from all angles. Continuous readings of fluctuations of drafts, air velocities, slight pressure changes, as well as vacuums and differentials, can be observed while adjustments are made. Available in a range of sizes and calibrations. Request Bulletin No. 205.



No. 102—Portable Inclined, 0'2" Water



No. 104—104.8—Portable Vertical, 0-8" Water

F. W. Dwyer Mfg. Co.

305 S. Western Ave.
Chicago 12, Ill.

SPECIFY THE BEST

PHILADELPHIA

THERMOMETERS AND THERMAL CONTROLS

Since 1905

Our Leadership for nearly a half century is your assurance of complete satisfaction when you specify a "Philadelphia" instrument.

Steady, accurate and dependable performance is guaranteed.
Feel free to consult with our specialized staff on any problem in our field.

SEND FOR CATALOG 110A

PHILADELPHIA THERMOMETER CO.

4400 N. Sixth St. • Philadelphia 40, Pa.

SPECIFY

wheelco

CAPACITROL WITH CAPACILINE

FOR ACCURACY

MODEL 252P CAPACITROL WITH CAPACILINE

INSTANT RESPONSE

PRECISE CONTROL

NO TIME LAGS

Capacitrol is proven in industry.

In the plastics industry where close limit temperature control is vital, Wheelco Capacitrol 252P with built-in Capaciline offers a low cost equivalent of proportioning control. No more over-riding or time lags to cause rejections and unsatisfactory production. "On-off" variations due to heat transfer lags are reduced to a minimum . . . without affecting accuracy of temperature readings. Specify Wheelco Capacitrol 252P to provide positive temperature control for plastic processing.

WRITE FOR BULLETINS 292-1 and PC-1

BARBER COLMAN

Instrumentality

wheelco instruments division

BARBER-COLMAN COMPANY

1219 ROCK ST. • ROCKFORD, ILLINOIS

R

I

O

or c
duce
inte
conr
impu
diff
sens
indic
or c
the
empi
figu
mult
the
appl
mete
mete

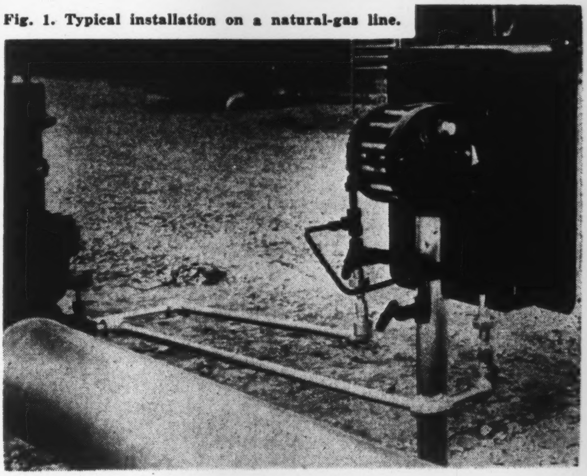
Bo
diffe
able
stage
of n
Howe
of r
rapid
type
This

JOURNAL of the
Southern California Meter Association

President: F. M. Partridge
Auditor: C. B. McKinney
Vice-President: James A. Serey, Jr.
Past President: H. C. Bennett
Secretary-Treasurer: Geo. H. Forster, Jr., 2916 Eucalyptus Ave., Long Beach 6, Calif.

Important factors associated with rupture-proof dual-bellows flowmeters include bellows construction, temperature compensation, range springs, ease of servicing, freedom from over-range damage, high sensitivity, simple installation, and applicability over wide ranges of differential and static pressures.

Fig. 1. Typical installation on a natural-gas line.



RUPTURE-PROOF BELLOWS-TYPE ORIFICE METERS

By A. I. THOMPSON
Barton Instrument Corporation

ORIFICE-TYPE flowmeters are composed of three essential elements—(1) the primary element or orifice in the flow line, which produces the differential pressure, (2) the intermediate element or piping which connects and transmits the differential impulse to (3) the final element, or differential-pressure meter, which senses the differential pressure and indicates this information on a scale or chart of flow. This article discusses the bellows-type final element. The empirical data and procedures used for figuring meter constants or orifice multipliers, as developed by the ASME, the AGA, the SCMA, the CNGA, etc., apply equally well to bellows-type meters and mercury-type differential meters.

HISTORY

Both bellows-type and mercury-type differential-pressure meters were available 35 years ago. At that time the stage of development of both types of meters was approximately equal. However, the mercury-manometer type of recording meter developed more rapidly than the early, single-bellows-type differential-pressure recorders. This is not surprising. Even at that time, the static pressure levels of systems were high enough to destroy the bellows if full line pressure was accidentally imposed across a single-bellows element. Although mercury-type meters also were disturbed by over-range, it was more simple and inexpensive to replace the mercury than to replace a bellows. In addition, the art of bellows manufacturing had not developed to its present level. No two bellows would give exactly the same meter characteristics. Also, the materials of construction could not prevent corrosion or damage to the bellows as the result of the attack of line fluids. However, advances in the metallurgy of stainless steels, as well as improved methods of bellows fabrication, have drastically changed that earlier picture.

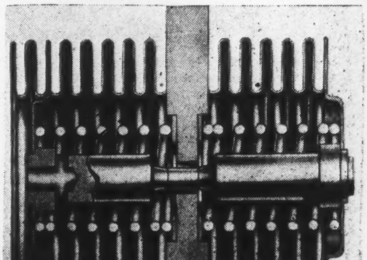


Fig. 2. Rupture-proof dual-bellows assembly.

Despite these problems, there was continuous effort on the part of various instrument companies to produce bellows-type meters. This drive was sparked by the recognition of the inherent advantages of the dry-type meter. These basic advantages, such as the omission of mercury and pressure bearing, could not be fully utilized until there was developed (1) a truly fool-proof method of preventing bellows damage when over ranged, and (2) a simple method of dampening the highly sensitive bellows.

CONSTRUCTION AND OPERATION

Bellows

During the second World War, a rupture-proof dual-bellows mechanism (Fig. 2) was developed that permitted full line pressure to be applied to one side of the meter with the other side open to atmosphere, without damage to the bellows. As shown in Fig. 2, a central plate separates the two pressure chambers. On this plate are mounted two bellows, one in the high-pressure chamber and one in the low-pressure chamber. The opposite ends of the bellows are closed by plates which are, in turn, joined by a stem that passes through the central plate. On this stem, on either side of the central plate, are mounted soft-seated valves that close against the center plate whenever an excessive differential pressure is applied in either direction. The internal volume of both bellows and the interconnecting passageway is completely filled with a liquid, such as ethylene glycol and water, and permanently sealed at the factory.

When a differential pressure is applied, liquid travels from inside the high-pressure bellows, through the annular passage, into the low-pressure bellows. If excessive differential pressure is applied, the valve on the center stem closes against the center plate and traps the liquid in the high-pressure bellows. As this liquid is essentially noncompressible, the pressure level in the high-pressure chamber may increase to the safe working pressure of the instrument without a corresponding increase in the low-pressure housing, and without damage to the bellows. As the liquid inside the high-pressure bellows is trapped, it supports the bellows and prevents any further change in its shape; as the hydrostatic pressure inside the bellows and the high-pressure housing is the same, there is no strain on the bellows; and as the over range valves are located in both the high- and low-pressure bellows, the differential pressure may be applied in the normal direction, or in the opposite direction, without damage.

Temperature Compensation

The fill liquid inside the bellows is permanently sealed within the bellows and never comes in contact with the fluid being measured. Some means must be provided to take care of its change in volume with increase or decrease of the temperature of the instrument. This is done by providing an extra bellows, attached to the high-pressure side of the instrument, which is free to float without being restrained by the center stem (Fig. 3). This extra chamber is connected to the main bellows chamber by a passageway through the closure plate of the high-pressure bellows. This extra bellows, or *temperature compensator*, acts as a surge chamber and permits the bellows fill liquid to expand or contract without affecting the pressure inside the bellows, or distorting the shape of the two main measuring bellows.

Calibration Range Spring

When differential pressure is applied, the movement of the bellows is opposed by the spring characteristics of the bellows themselves plus the action of *range springs* (Fig. 2). The spring rates determine the differential-pressure range. This instrument with internal range springs, as shown in Fig. 2, is available in differential-pressure ranges from 0-40 inches W.C. to 0-400 inches W.C.

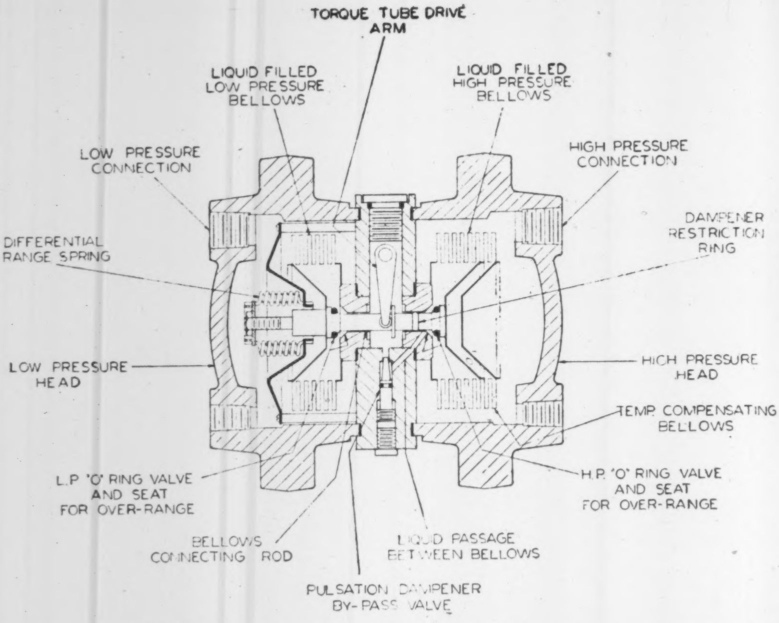

TORQUE TUBE DRIVE ARM
LIQUID FILLED LOW PRESSURE BELLOWS
LIQUID FILLED HIGH PRESSURE BELLOWS
LOW PRESSURE CONNECTION
HIGH PRESSURE CONNECTION
DAMPENER RESTRICTION RING
DIFFERENTIAL RANGE SPRING
LOW PRESSURE HEAD
HIGH PRESSURE HEAD
TEMP. COMPENSATING BELLOWS
L.P. 'O' RING VALVE AND SEAT FOR OVER-RANGE
H.P. 'O' RING VALVE AND SEAT FOR OVER-RANGE
BELLOWS CONNECTING ROD
LIQUID PASSAGE BETWEEN BELLOWS
PULSATION DAMPENER BY-PASS VALVE

Fig. 3. Sectional view of "Model 199" double-bellows differential-pressure unit with pulsation dampener and temperature-compensating bellows.

For lower differential ranges a larger unit (Fig. 3 and Fig. 4) was developed. In this type the calibration range springs are external of the bellows, a torque tube is used, an internal pulsation dampener is included, and the bellows are made of stainless steel. The calibration range spring assembly is composed of multiple springs operating in tension. They are welded to two rings designed so the larger external ring can be supported by four posts, and the smaller one can be threaded to the end of the center stem stud. This design simplifies range changes and enables one to make an approximate zero setting when changing the range.

In order to change the range of the smaller unit (Fig. 2), it is necessary to change the entire bellows-unit assembly. With the larger design (Fig. 4), only the range springs need be changed to change the differential-pressure range from 0-15 inches W.C. minimum to 0-300 inches W.C. maximum.

All of the wetted parts of the bellows unit assembly except the center plate are made of stainless steel. The bellows are 316 stainless steel. The standard springs are 18-8 stainless steel (#302), although they are now available in 8-18 stainless steel also. This latter material, known as "Iso-elastic," is intended for installations requiring extremely high accuracy and repeatability. The other parts are either 302 or 303 stainless steel, depending upon whether they are to be welded or machined.

Torque Tube

The motion of the bellows must be transmitted from the center stem to the recording portion of the meter. The small unit uses a lubricated pressure bearing with a take-off from a hard bearing surface on the end of the low-pressure bellows. The larger unit utilizes a torque-tube take-off.

A torque tube (Fig. 5) is a device for transmitting rotary motion through the wall of a pressurized vessel without the use of stuffing boxes or closely lapped shaft and bushing. It consists of a thin-walled *housing tube* welded at one end to the pressure vessel, and welded at the other end to a *torque shaft* which passes through the tube beyond the wall of the pressure vessel. When a torque is applied to the inner end of the housing at the point where it is welded to the torque shaft, the housing tube twists, but the shaft rotates. The outer end of the torque tube usually is not welded directly to the pressure vessel or housing; it is welded to a special fitting that can be sealed in the housing center plate with an "O" ring and a special lock nut. This provides a perfect seal and yet permits initial factory settings and adjustments. As the tube is welded at both ends and sealed in the center plate, there is absolutely no passageway for liquid or gas to escape through this device. As the tube is only twisted through about 25 percent of its workable range, it does not fatigue. The only fluid contacting the torque tube is atmospheric air on the outside and fill liquid on the inside. Therefore the torque tube can be supported by a needle bearing, and the arm that transmits the rotary motion to the torque tube can be driven by a ball bearing with an absolute minimum of friction. As the highly responsive bearings are continuously bathed in a clean lubricating fluid that never becomes oxidized or contaminated, they retain

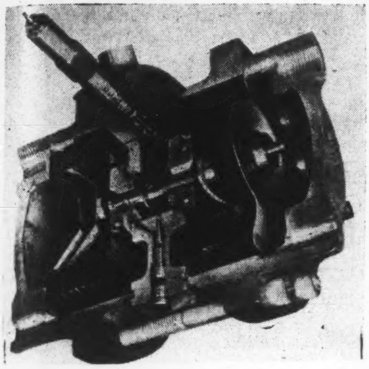


Fig. 4. "Model 199" double-bellows assembly.

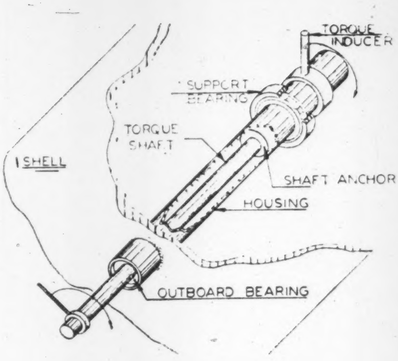


Fig. 5. Details of torque tube.

their desirable operating characteristics for the life of the instrument.

Pulsation Dampener

The internal pulsation dampener (Fig. 3) consists of a highly polished free-floating piston ring placed on the central shaft within the cylindrical portion of the high-pressure valve seat. It acts as a frictionless restrictor to the flow of fill liquid from one bellows to the other. To provide for adjustment of the degree of dampening, a needle valve is included in the center plate. This allows the fill liquid to by-pass around the restriction ring. By virtue of the novel "O"-ring design, the by-pass valve can be opened or closed while the instrument is in operation.

Housing

The housing consists of the high- and low-pressure heads plus the center plate, which also is part of the bellows unit. The heads are secured to the center plate with twelve bolts, using "Durabla" gaskets for sealing. Housings are available with safe working pressure of 1000 psig., 2500 psig., and 4500 psig. These ratings have a 4 to 1 safety factor based on the API and ASME Code for unfired pressure vessels. The heads are easily removed for range change.

CHARACTERISTIC FEATURES

The rupture-proof type of bellows differential-pressure recorder has many desirable operational features. Chief among them is that there is no mercury used in the instrument. This eliminates (1) the initial expense of mercury catch pots, special piping, and manifolding, (2) the cost of seal pots, (3) the cost of replacing lost mercury, (4) the contamination of the line fluids, (5) the destruction of copper bearing alloy parts down the line, (6) the explosion hazard in the presence of ammonia, and others related to servicing.

Another feature of operational importance is ability to withstand overrange without damage to the measuring system, permitting unskilled personnel to put the meter into operation. This has been demonstrated by tests in which an instrument was over loaded a half a million times with a differential pressure 300 times greater than the differential-pressure range of the instrument. It checked within 1 percent after the tests.

The use of a torque tube instead of pressure bearing eliminates leaks. This is important when handling high-pressure natural gas, ammonia, oxygen, hydrogen sulfide, carbon dioxide, etc. As all parts in contact with the fluid being measured, except the housing, are of 18-8 stainless steel, there is no corrosion—a feature proven in the sour gas fields.

As there are no moving parts except bellows and springs, there are no bearings, pivots, chains, etc. to become fouled and alter the sensitivity of the meter. This assures permanently high sensitivity because a bellows-type instrument has a low inertia and is, therefore, basically sensitive. Without affecting sensitivity, an operator can select the exact degree of inertia required on any installation by adjusting the pulsation dampener. Although this is an internal adjustment, it is made externally while the unit is in operation under full line pressure, without danger of losing the fill liquid or the fluid being measured.

As the differential-pressure unit is temperature compensated for fill-liquid expansion, and as the range springs have a low temperature coefficient of expansion, changes in ambient temperature have little effect on the calibration. In contrast, temperature changes affect mercury meters, some more than others. The temperature limitations on a standard bellows-type meter are −20 deg. F. to +200 deg. F. for continuous duty. Special meters have been made for temperatures as low as −100 deg. F.

The guaranteed accuracy of the instrument is better than ½ percent of the differential-pressure range. The range springs contribute heavily to this accuracy. Being corrosion resistant they do not change cross-section and lose their characteristics. Also, their hysteresis is small, and the tension-type multiple-spring design insures accurate linear deflection. Where the highest degree of accuracy is desired, the special "Iso-elastic" springs should be used because their temperature coefficient of expansion is almost zero; their spring characteristics are better; and tests thus far indicate their average hysteresis to be less than 0.1 percent of full scale.

Over pressuring of rupture-proof bellows units has virtually no effect on the calibration, nor does it shift the instrument zero. This was verified by a user who applied static pressures from 25 inches W.C. to 1000 psig., the safe working pressure, in about 10 or 12 steps, to the low-pressure side, with the high-pressure side open to atmosphere. After each over range the instrument returned to true zero with no shift.

The volume displacement of the differential-pressure units is small—1.5 cubic inches for full-scale deflection, or about 0.07 of a cubic inch for a 5-percent change in range. This is important when, because of material or temperature limitations, it is necessary to use seals. When make-up condensate is the sealing medium, the seal pots or condensing chambers can be omitted without sacrificing permanent accuracy for a long duration. For example, on a steam-flow installation using a 100-inch W.C. unit with ½-inch piping, and assuming a normal flow rate of 80 percent, a change of 5 to 10 percent of flow rate would introduce an error of only about 1 percent of flow. This would be a momentary error as the make-up condensate would immediately replace the void. A larger differential range would give proportionately less error because the bellows unit (and therefore the displacement) is the same for all ranges.

For wide flow variations, two differential-pressure units can be mounted on the back of the same recorder case, one with a low differential-pressure range spring for low flow, and the other one with a differential-pressure range spring 4 to 16 times stronger for a high flow of 2 to 4 times the low flow. The two units are connected to the same orifice plate. When the differential-pressure range of the low-range unit is exceeded, its pen comes to rest at the edge of the chart and the higher range unit takes over, operating a second pen that will already be at ¼ of the chart. Thus a complete record of the wide range of flow can be made available on a single chart, together with a third and fourth pen for static pressure and temperature if required. The over-loading of the low-range unit during periods of high flow causes no damage because of the rupture-proof principle.

The dual-type rupture-proof bellows is used not only to actuate recorders; it is equally suitable for driving indicators, controllers, and transmitters, both pneumatic and electric, the latter being particularly important when telemetering flow in gas transmission and distribution.

INSTALLATION

Installation of the dual-bellows recording meter is governed by accepted flowmetering practice, as for any other orifice meter. However, certain features make its installation simpler and easier. For example, as the meter contains no mercury, the catch pots and special piping manifolds can be omitted. Also, accurate leveling is not required and inexpensive pipe saddles can be used in lieu of leveling saddles. As accurate leveling is not required, the meter is an ideal portable meter for temporary installations or for testing field meters. A portable indicator, accurately calibrated in the shop, can be used as a secondary standard for field checking instead of the fragile and cumbersome water column.

The meter body is self draining because there are no cups or traps to catch condensate or liquid. Therefore, to take full advantage of this feature, the instrument should be piped from the bottom connections of the meter chambers, with the lead lines running downwards to the orifice plate. This permits the instrument to automatically drain itself of any condensate that may form from wet gas during a decrease in temperature. To promote this feature it is highly desirable to eliminate the block valves in the impulse lines in the meter manifold; instead, use only full-opening plug valves at the orifice flanges.

A typical installation on a natural-gas line is illustrated in Fig. 1. When measuring natural gas, even when temperatures and pressures are right for hydrate formation, this method of installation has proven satisfactory. Three things to bear in mind under such conditions are: (1) The impulse lines must connect to the bottom housing connections, (2) it is preferable to have the ½-inch connections at the bottom and to use ½-inch lines, and (3) do not blow-down the meter when hydrates are present in the impulse lines or the meter.

When the instrument has been piped up, but before the block valves are opened, the instrument should be checked for zero. Although it is not necessary to level the instrument precisely, the zero position will shift slightly if the instrument is installed with the meter tipped quite a bit from the perpendicular. This does not alter the calibration of the instrument; by returning the pen to zero with the zero adjustment provided for this purpose, the instrument will be in perfect calibration.

The rupture-proof feature should be considered as a safety measure and should not be abused. Therefore, the by-pass valve should be open when the instrument is being pressurized. However, overload causes no damage other than perhaps flinging the ink out of the pen.

Two meters often are placed in the same flow line for checking one against the other. This is particularly likely to occur when someone is testing a meter that is new to him. If this is done, it should be recognized that the flow of gas through an orifice plate can spontaneously develop pulsation in the gas stream. Pulsative flows passing through an orifice plate are subject to peculiar disturbances. As pulsative conditions in a gas stream can generate spontaneously across an orifice plate, it means that peculiar conditions can exist in one meter installation and not in another one 50 feet from it. Even if the pulsative condition develops to the same degree across both plates, the two meters will not give the same readings unless the piping from the orifice plate to each meter is identical, and the volumes of the two chambers of both meters are identical. This problem of pulsative conditions in gas-flow measurement is an extremely complicated one.

Service and Maintenance

The meter body is rugged, simple, and easy to service. Some common servicing problems that are eliminated are: (1) The health hazzard of mercury poisoning; (2) the danger of explosion from unstable mercury salts when used on ammonia; (3) the necessity of "wet calibration" when the impulse lines are filled with sealing fluid or condensate; (4) the troubles and expense of reclaiming and replacing mercury blown by over ranging; and (5) the periodic cleaning, repairing, replacing and lubricating of exposed parts such as pivots, chains, knife edges, ground joints, pressure bearings, or stuffing boxes. The few moving parts are hermetically sealed in a pure lubricant that is never oxidized or contaminated.

The sequence of operation of the manifold valves is not critical and, therefore, checking the instrument zero in the field is simplified. One important point that should be remembered, however, when zero-checking any kind of orifice meter on a pulsating gas flow is that *both* valves should be closed (not just one) and the by-pass valve should be opened. This guards against a false zero caused by a pulsative condition.

With the dual-bellows meter it is not necessary to bleed off the gas pressure from the high- and low-pressure chambers when zero check is being made because the calibration and the zero position of the instrument are not affected by static pressure level. A meter calibrated at atmospheric level is correct at high pressure levels because no correction has to be made for the change in weight of the differential gas column which in turn is caused by the increase in gas density due to higher pressure. Another point is that a meter operating on a highly pulsating flow will be heavily damped; therefore, one should remember to open the dampener valve wide when checking zero.

Calibration in the shop or laboratory is accomplished by attaching the high-pressure side of the instrument in parallel with a water column to a source of controlled low-pressure air. The low-pressure housing should be open to atmosphere and the dampener valve should be opened wide. The usual steps in calibrating a pressure spiral are followed in calibrating this bellows meter—namely, check zero, check full-scale travel against a pressure equal to the differential range and, finally, check mid-scale against half the range. Adjustments are made to the length of the adjustable arm on the pen shaft to correct for deviations from the desired range, and to the length of the adjustable link to correct for minor deviations from linearity. This same test can be made in the field by using an aspirator bulb instead of an air supply. Care should be taken to guard against leaks and to prevent any sealed pressure from remaining in the sun too long because the air will expand due to the radiant heat of the sun. This will result in unstable readings and lead to errors.

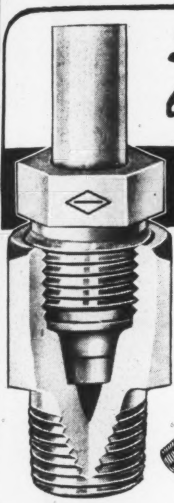
The stainless-steel construction eliminates corrosion in most applications. However, if fluids such as salt water in the presence of oxygen, wet chlorine gas, or dilute sulphuric acid should corrode the bellows, the entire bellows assembly should be replaced. The replacement can be managed by any competent instrument mechanic. It can be done in the instrument shop or in the field. In either case, the instrument is disconnected from the lead lines, the 12 head bolts are removed and the two heads are taken off. The drive arm is disconnected from the torque tube shaft in the recorder case. The three screws holding the bellows unit assembly to the mounting bracket are then loosened and removed. This frees the bellows-unit assembly which then may be taken from the instrument and replaced; the assembly steps are followed in the reverse order. Due to minor tolerances in manufacturing it is always necessary to recalibrate after replacing a bellows assembly. It is standard practice to furnish each new bellows assembly with a calibration range spring assembly. Therefore, the basic zero setting is already made. It is then only necessary to adjust for exact micrometer zero on the pen arm or pen shaft and adjust for pen travel and linearity in the recorder case.

There is no required periodic maintenance such as lubrication or regular cleaning. Of course, if solids collect around the bellows, they have to be removed periodically to avoid errors. However, except for unusual circumstances, the presence of oil, condensate, or sulphur-bearing gases do not disturb the instrument accuracy.

It has been reported by users that the dual-bellows rupture-proof differential-pressure recorder requires so little maintenance that it is ideal for areas wherein excessive maintenance costs have been experienced with other varieties of meters.

December Meeting: Thursday, the 18th, Rio Hondo Country Club, Downey, Calif.

Feature: "Past Presidents' Night." Mr. T. K. M. Smith, of Pacific Lighting Gas Supply Company, who was the first president of the Southern California Meter Association, will speak on "Twenty-Five Years of Progress" or "Metering Then and Now."



Saves man hours by faster assembly

Hi-Duty FITTING

THE TUBE COUPLING THAT WITHSTANDS VIBRATION

EASIER AND QUICKER TO ASSEMBLE
Fitting comes with nut assembled. Simply push tube into fitting and tighten nut. No loose sleeve to contend with . . . no tube flaring required. Makes repeated tight reconnections.

MORE CAPACITY TO WITHSTAND VIBRATION
because tubing deformation is kept at a minimum. Imperial Hi-Duty Fittings withstand over 5 times as much vibration as joints made with Compression or Flared brass fittings.

For tubing from ⅛" to ¾" O.D.

Available in Brass or Aluminum

Ask for Catalog 350 and Bulletin 365 for complete information.
See your Industrial Supply House.

THE IMPERIAL BRASS MFG. CO., 1204 W. Harrison St., Chicago 7

IMPERIAL
Pioneers in Tube Fittings and Tube Working Tools

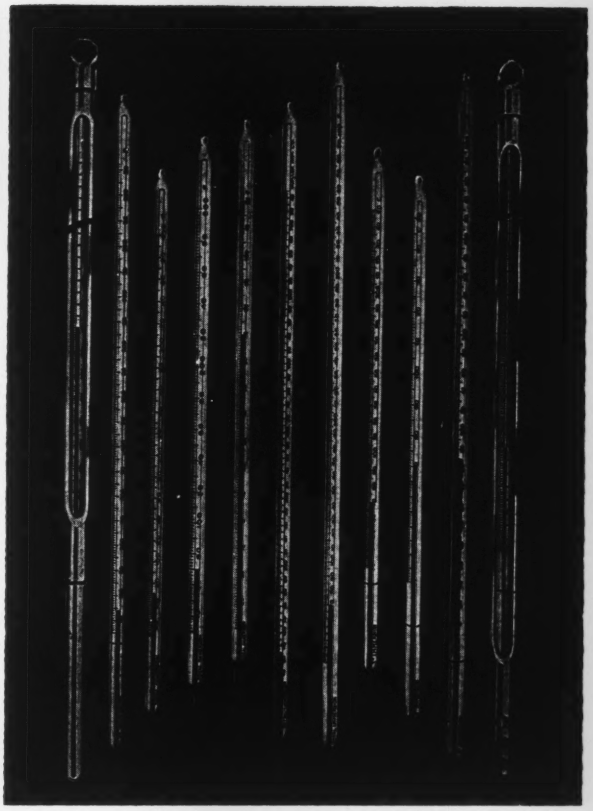
Eliminate
PROCESS LEAD LINES
in Pressure Measurement

. . . by using the CONO PNEUMATIC PRESSURE TRANSMITTER. Bolts directly to the tank. Operates through diaphragm or bellows using force-balance principle. Ideal for service involving viscous substances or materials that solidify in conventional measuring elements. For pressure transmission, liquid level in open tanks, bulk material storage bins, etc. Write today for BULLETIN P-25 20.

CONOFLOW CORPORATION
2100 ARCH ST.
PHILADELPHIA 3, PA.

Cono-Controls

CC-113R



Pre-Tested Dependability

The standard of MOELLER Accuracy for more than four generations

There is no guess work when you use Moeller Etched Stem Thermometers. Each instrument is designed to fit individual testing problems — built to give you lasting satisfaction — guaranteed through factory pre-tested methods with the scientific thoroughness that assures perfection in all Moeller products.

Let Moeller solve your temperature indicating, recording and testing problems, Now!

Send for catalogs and literature on

INDUSTRIAL, LABORATORY
AND RECORDING THERMOMETERS
VACUUM GAUGES • HYGROMETERS
HYDROMETERS • PSYCHROMETERS
AND MARINE SPECIALTIES

MOELLER
INSTRUMENT COMPANY
132nd ST. and 89th AVE. • RICHMOND HILL 18, N. Y.
Representatives in Principal Cities

FOR NEW BUSINESS FROM OVERSEAS–

wise manufacturers and exporters everywhere use an international journal—for none other has the pulling power of a publication which penetrates into all world markets.

MACHINERY LLOYD is such a journal. Two editions are published every fortnight—the OVERSEAS EDITION which is mailed to the British Dominions and Colonies, North, Central and South America and the Middle and Far East; and the EUROPEAN EDITION, which is read by buyers in Great Britain, every country throughout the Continent of Europe, and the French and Belgian overseas possessions. The fortnightly circulation of each edition is 12,000 copies, and the two cover more than 120,000 different addresses in classified rotation.

MACHINERY LLOYD

To readers of this advertisement whose interests lie in import rather than export, we extend a cordial invitation to subscribe to the OVERSEAS EDITION. Every issue is packed with up-to-date technical information on new machines and processes and contains a digest of industrial news from our own correspondents in Overseas markets. The subscription fee is $7.00 for 26 issues a year.

Introductions to British suppliers of all types of engineering equipment. Answers to technical problems. Disposal or acquisition of rights to manufacture and sell under license. Assistance in securing agencies from reputable British manufacturers.

SERVICES FREE

PUBLISHED IN ENGLAND
BUT
READ EVERYWHERE

Member of the AUDIT BUREAU of CIRCULATIONS

Ask for advertisement rate cards and free specimen copies—

MACHINERY LLOYD
6 Cavendish Place, Regent Street,
LONDON, W.1—ENGLAND

LUBE-OIL PROCESSING

Continued from page 1570

one group and closes all those not listed, he knows he has a certain sequence of operation.

Water Removal at Furfural Unit

Let us now discuss a case of over instrumentation which caused much unnecessary work both for operators and instrument men. This case involves the Water Removal Tower of the solvent recovery system. Final stripping of furfural from both raffinate and extract is with steam. Thus the condensate from these stripping towers contains both water and furfural. A primary separation of the furfural and water in the liquid state can be made by a decanter. However, the best separation which can be made in a decanter is about 80 percent at 110 deg. F., which temperature is about as good as can be expected with 92-degree cooling water. This means that 20 percent of the furfural coming into the decanter remains in the water layer. It is the function of the Water Removal Tower (Fig. 2) to recover the furfural which does not settle out of the water. This is done by a distillation process in which all the furfural and some water are distilled overhead. The boiling point of this mixture is lower than the boiling point of pure water. In this system the water layer from the decanter is pumped on to the top tray of the Water Removal Tower. Exhaust steam is introduced into the bottom of the tower to supply the heat to distill the water-furfural feed mixture.

The control system shown in Fig. 2 looks feasible. With steam as the heating medium the temperature controller controlling the steam should assure sufficient heat to the tower. However, the boiling point of furfural-water mixtures with compositions varying from 93-percent furfural and 7-percent water to a 5-percent furfural and 95-percent water all have a constant boiling point of about 208 deg. F. at atmospheric pressure. Soon after operation was started it was noticed that no matter how much steam was put in the bottom of the tower the temperature recorded on the TRC did not change. After many hours of trying to make the instrumentation work, a review of the process factors was made. A simple graph of furfural-water boiling point versus percent composition showed why the control did not work.

The TRC was removed and the steam is now set by hand at a point where experience has shown that enough heat will be added to distill all the furfural from the water layer of the decanter. A sniff of the water from the bottom of the tower checks that enough steam is being added. The only precaution necessary is to see that excess steam does not overload the condensing system or decanter.

This illustrates how a good understanding of processing can be useful to an instrument engineer. The instrument man need not be a process engineer, but he should dig into fundamental concepts involved in the system he is instrumenting.

Dewaxing Units

We now pass along to the MEK dewaxing units, where there are two cases which have some unusual features. The first of these deals with the instrumentation of the control on the waxy charge to the dewaxing unit, blending of solvent with this waxy oil, and distribution of the resultant charge mix into three parallel streams through double pipe exchangers and chillers (Fig. 3).

The original system installed, shown by the solid lines in Fig. 3, was conventional. It consisted of flow controllers on each of the three charge mix streams to the exchangers and chillers. The waxy charge was not controlled directly, but its flow was the primary flow of a ratio controller which controlled a secondary solvent flow from a solvent receiver. As this stream of solvent was not enough to supply the full quantity needed, an auxiliary supply of solvent was required. This came from another source under control of a liquid level on another receiver. This control system looks perfectly operable. There were two things, however, which called for changing the instrumentation.

First, this system provided no protection against filling the chilling system with straight waxy oil and thus plugging it. Men in dewaxing plants know only too well the lost production that results when the chilling system is plugged by straight waxy oil. This happens if a solvent pump is lost for any reason; the controlling flowmeters on the three split streams don't know solvent has been lost and they keep asking for the same flow. With the solvent flow reduced the waxy oil flow tries to meet the demand. The other solvent flow may try to come up, but will be insufficient and soon the pump loses suction or the liquid level shuts off the flow, depending on which pump was lost. No matter how good the operators are, this condition is bound to happen sooner or later.

Before we discuss the moves which were made to protect against this condition, let us turn to another condition which existed in our plant and which could happen in any similar set up. The waxy oil charge pump had head characteristics which, at some plant capacities, allowed it to put up a head against which the solvent pumps could not pump. This condition leads to exactly the same plugging of the chilling system with waxy oil as was described. Perhaps the heads on the solvent and waxy charge pumps could be better balanced, but such balancing of heads with centrifugal pumps is next to impossible to cover all capacity ranges.

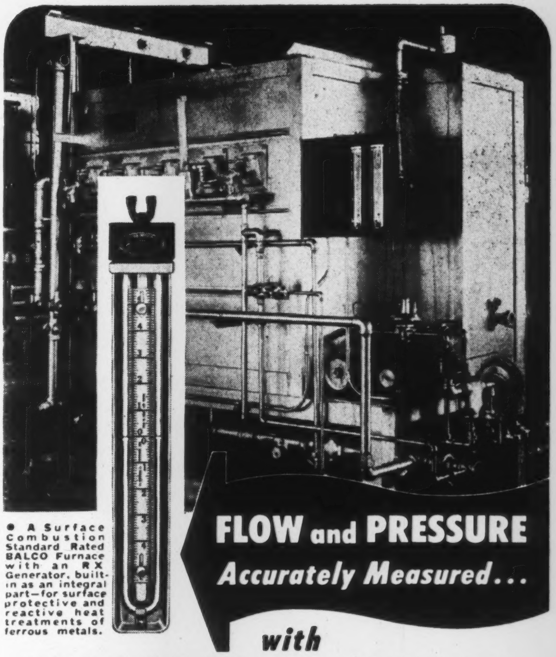
This problem was put up to our instrument department. They recommended that the instruments shown dotted in Fig. 3 be installed. These instruments are (1) a *pressure controller*, actuated by a pressure tap on the combined charge mix line to the chiller flow controllers, controlling (2) a *valve* in the waxy oil line, and (3) an *air relay* from the transmitter air of the solvent flow of the ratio controller. This relay supplies air to the positioner on the valve installed in the waxy oil line. Now let us suppose that a solvent pump is lost. This time either of two things happen, both of which will shut off the waxy oil so it does not plug the chillers. If the transmitter air of the solvent flow goes below the relay set point, the relay shuts off the waxy oil control valve by cutting off the supply air. If the solvent flow is reduced but not low enough to work the relay, the low-dilution waxy oil mixture when chilled raises the pressure in the chillers and the pressure controller starts reducing the amount of waxy oil being charged. Thus the new instruments furnish protection if a solvent pump is lost.

What do these instruments do for the condition of high head on the waxy oil pump? The pressure controller can be set at a point where the valve controlled by the pressure controller throttles the waxy oil stream so the solvent pumps can function as desired without having to buck the extremely high head of the waxy oil pump. Thus the new set up can operate as planned originally, but with protection against operating interruptions due to plugged chillers. Changes in plant throughputs can be controlled easily and smoothly by changing the settings on the three flow controllers on the split streams going to the chillers.

Compressor Instrumentation

The second problem at the MEK plants deals with the main instrumentation of the refrigeration Propane compressors (Fig. 4) which take care of the refrigeration for both MEK plants. In this system there are three 1165-ton compressors. One takes care of MEK-1, one takes care of MEK-2, and the other is a common spare. One normal compressor is driven by non-condensing turbines which take 600-pound steam directly from the boilers and discharge into the 200-pound refinery system where it is used for heating and prime movers throughout the rest of the plant. The other normal compressor is driven by a condensing turbine and the spare compressor has a non-condensing turbine drive.

For steady operation it is essential that the operating compressors maintain constant suction pressure. The compressors operate at constant speed because with centrifugal compressors of this size it is impractical to attempt capacity control by changing the speed of the compressor. This means that other means must be found to maintain a steady suction pressure. The MEK system does not have rapid or frequent changes in refrigeration requirements, even though filters are regularly being taken off for washing, because load



● A Surface Combustion Standard Rated BALCO Furnace with an RX Generator, built-in as an integral part—for surface protective and reactive heat treatments of ferrous metals.

FLOW and PRESSURE
Accurately Measured...
with

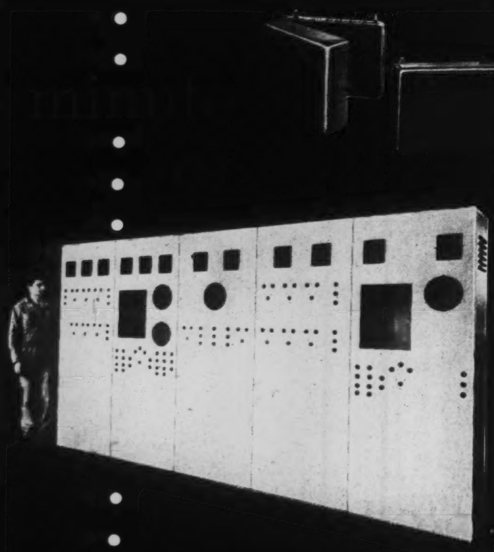
MERIAM MANOMETERS

These two Meriam Manometers are used as gas flow measurement instruments for the built-in RX Atmosphere Generator. One manometer measures the flow of the proportioned air-gas mixture to the reaction tube; the other measures the flow of "enriching" gas that is mixed with the atmosphere gas just before it is introduced into the furnace muffle.

The manometers are of the standard U-Type Clean-Out design. The clean-out feature permits filling and cleaning of the U-tube without disconnecting piping to manometer. Of rugged and simple construction, Meriam Manometers are widely recognized throughout industry for their sensitivity and accuracy in the measurement of practically all kinds of liquids and gases. Helpful information is contained in Bulletin 1 — gladly sent upon request.

THE MERIAM INSTRUMENT CO.
10958 MADISON AVENUE • CLEVELAND 2, OHIO
WESTERN DIVISION: 4760 E. OLYMPIC BLVD., LOS ANGELES 22, CALIF.
IN CANADA: PEACOCK BROS., LTD., MONTREAL

MERIAM Instruments
ESTABLISHED 1911
MANOMETERS, METERS AND GAUGES FOR THE ACCURATE MEASUREMENT OF PRESSURES, VACUUMS AND FLOWS OF LIQUIDS AND GASES



KIRK AND BLUM

Electrical Enclosures

Any size . . . any shape . . . any number . . . for whatever requirement . . . KIRK & BLUM fabricating experience and facilities are at your service. Built to exacting specifications . . . we custom fabricate sheet steel, light plate, stainless, aluminum, monel and other alloys to ½" in thickness.

Write for your copy of the latest KIRK & BLUM Electrical Enclosures Booklet . . . for prompt quotation on any job send prints to The KIRK & BLUM MFG. CO., 3111 Forrer Street, Cincinnati 9, Ohio

Control Desks • Instrument Panels
Electrical Enclosures • Cubicles
Control Panels • Transformer Tanks
Outdoor Electrical Enclosures
Switch Gear Housings • Test Stands

KIRK AND BLUM

METAL FABRICATION

changes are small compared with the total refrigeration load.

The easiest way to maintain a steady suction pressure would be to by-pass some of the compressor discharge directly back to the suction; this was done. On the surface it seems that a by-pass control operated by a pressure controller would take care of the full requirements for such a system. However, where a centrifugal compressor is used, the by-pass control is not the complete answer. This is due to a characteristic of the centrifugal compressor. It is well known that if the flow to a centrifugal compressor is below some critical point, the compressor really acts up. It squeals and develops a puffing action which can become violent. The machine shakes and lines bounce around like steam lines with water hammer. Since this is a flow problem, it is necessary to augment this compressor control system with a flow controller to prevent the flow from the compressor from falling below the critical point which causes "puffing."

The instrumentation of the dual pressure and flow controls is illustrated in Fig. 4. Both pressure controller and flow controller are tied into an automatic selector. As long as the flow from the compressor is above the set minimum, the pressure controller functions as a by-pass controller. However, if the flow falls below a selected minimum, the flow controller takes over, regardless of the pressure condition. This makes sure that the compressor does not develop the dangerous surge due to low flow.

If the pressure goes up in the suction trap, something must be done to adjust the load to the compressor which is affecting the pressure. The selector-control air is connected to the control valve through a relay. The function of the relay is to take the control away from the selector should the suction trap pressure reach 15 pounds. The by-pass valve is then closed by the relay. This protects the over-pressuring of the suction trap and consequent overloading of the compressors by high suction pressure.

ROTAMETER ON HOT RAFFINATE

A rotameter installed on the hot raffinate line leaving the Duo-Sol plant checks our yield-department figures within 1 to 2 percent. This meter operates at about 400 deg. F., with possibility of temperatures as high as 550 deg. F. Such a meter eliminates the sealing problem and approaches a range where displacement meters become expensive and hard to maintain. At the time this instrument was installed it was an innovation. The rapid rate of improvement, use, and acceptance of differential-pressure meters for flow may make this particular report less important. However, the application of this meter in this service and with this accuracy may be of interest to some instrument men.

DUO-SOL EXTRACTOR SYSTEM

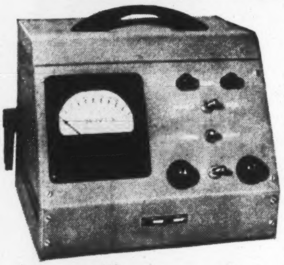
The Duo-Sol extractor system (Fig. 5) consists of seven counter-flow mixing and settling steps. One solvent (low-specific-gravity Propane) enters the No.-1 end of the system and high-specific-gravity solvent Selecto (mixture of Phenol and Cresol) enters the other end counter flow. In each extractor the Propane layer rises to the top and the Selecto layer settles. This means that the Propane moves through the system by the pressure of the pump that charges it because all extractors are completely full. It is necessary to pump the Selecto from each compartment to the next, and a transfer pump is provided for each extractor. In each extractor, or settler, an inter-face level is maintained between the heavy solvent layer and the light solvent layer.

At this point the question invariably is asked: "Why don't they use inter-face floats to control the transfer?" This question would be even more insistent when you observe the Duo-Sol operation and see a modern fully-instrumented plant with everything automatic except the extractor system. Here you will see an operator walking in front of the extractors, observing inter-face levels in a gage glass, and manually adjusting the discharge valve on the transfer pumps to hold the levels.

The process calculations on the Duo-Sol extraction system are empirical and have been developed on theory but weighted by plant experience. The design of the Cit-Con

IT'S PORTABLE, VERSATILE, ACCURATE!

THE NEW GOW-MAC GAS-MASTER



—featuring simple operation and 30-second response

FOR LABORATORY OR PLANT—Get accurate, reproducible readings anywhere with the lightweight, compact, portable GAS-MASTER.

SIMPLE TO USE—Enables the technician to read changes in gaseous mixtures in minutes, saves hours of laboratory work by the chemist. Recorder chart gives perfect summary of test data.

LESS THAN 30 SECONDS required for full deflection from most gas quality changes, at sample flow rate of only 100 ccpm.

—versatile operation

Any simple gas or mixture can be used for reference. Monitors adsorption, drier and reaction towers by "comparative analysis." Multi-applications widened by double gas passages, optional use of indicating meter or your recorder, and calibrating resistor in galvanometer circuit for optimum use of full-scale range.

FOR COMPLETE DATA request literature and state your specific gas analysis problem.

GOW-MAC INSTRUMENT CO.
22 LAWRENCE ST., NEWARK 5, NEW JERSEY

CUT COSTS on MOISTURE CONTROL

KEMP DYNAMIC DRYERS DRY INSTRUMENT AIR TO LOW DEW POINTS FOR AS LITTLE AS 1/4c PER MCF.

Kemp Dryers save industry thousands of dollars a year—because they protect costly instruments from damage due to moisture in the air or air source. Operation is guaranteed to your specifications, and standard models are available for any instrument air drying operation—whether it's large or small.

Send For Information. Kemp has a Dynamic Dryer designed for every application. Find out how Kemp can solve your problem. Write today—no obligation.

KEMP OF BALTIMORE

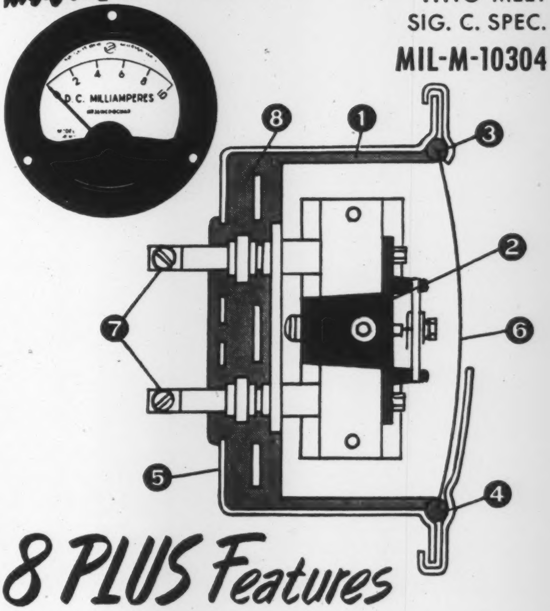
DYNAMIC DRYERS
Write for Bulletin D-27 for technical information. C. M. KEMP MFG. COMPANY, 405 E. Oliver Street, Baltimore 2, Maryland.

CARBURETORS • BURNERS • FIRE CHECKS • ATMOSPHERE GENERATORS • ADSORPTIVE DRYERS • METAL MELTING UNITS SINGEING EQUIPMENT • SPECIAL EQUIPMENT

Available NOW!

RUGGEDIZED METERS

...TO MEET SIG. C. SPEC. MIL-M-10304



8 PLUS Features

Extra "Ruggedized" Features

① Meter movement completely shock-mounted and housed in rubber-lined case.

② Meter movement supported by die-cast frame for greater strength and increased accuracy.

③ Observation window rubber grommeted and sealed to rubber lining of case—providing hermetical seal of high dielectric materials.

④ Non-rigid mounting of observation window with rubber grommet increases resistance to shock.

⑤ Each meter designed and built by SUN to highest quality and precision standards.

Extra Installation Advantages

⑥ Slight convexity of observation window reduces chance of accidental breakage during installation or shipment.

⑦ Terminals side-tapped and provided with tinned binding screws to facilitate wiring with or without wire lugs or by pressure, soldering or both.

⑧ Breakage or damage in wiring is reduced through non-rigid mounting of terminals and use of flexible interior conductors.

Building rugged electric meters is not new to SUN . For over 20 years, the automotive industry has depended on SUN as one of the largest "D'Arsonval-type" meter manufacturers—to produce rugged, tough meters that will stand up under the abuse and rough handling of portable field instruments used in automotive repair work. SUN "Ruggedized" Meters not only meet Specification MIL-M-10304 (Sig.C.)—but also embody many *plus* features that make installation easier, faster and help prevent assembly or shipping damage. Complete data bulletin on SUN "Ruggedized" Meters available on request.

SUN "Ruggedized" Meters are available as D-C Volt Meters, Ammeters, Milli-ammeters and Micro-ammeters and also may be ordered as rectifier type A-C instruments.

SUN ELECTRIC CORPORATION

6060E

from
Annealing Ovens
to
Xenon Extractors

Through the Industrial Gamut, from Annealing Ovens to Xenon Extractors, where-ever heat is generated and used, there is need for—

Burling
TEMPERATURE
Controls

SIMPLE in construction and operation there is practically nothing to get out of order.

ACCURATE to 1/4 of one percent or 1 or 2 degrees—the Burling Control Action is very rapid.

VARIED in thermal range—twelve (12) models of Burling Controls are available to meet requirements from Minus 300 F to Plus 1800 F.

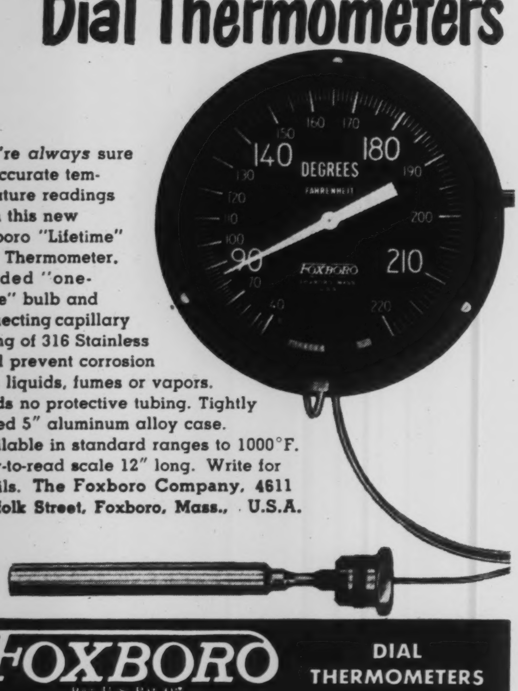
PRICED very moderately and therefore available for many multiple installations in a plant.

AVAILABLE also in three types—Electric—Pneumatic and Automatic Valve.

Ask for new catalog G17

BURLING INSTRUMENT COMPANY
9 VOSE AVENUE SOUTH ORANGE, N. J.
Temperature Controls since 1935.

NEW "Lifetime" Dial Thermometers



You're *always* sure of accurate temperature readings with this new Foxboro "Lifetime" Dial Thermometer. Welded "one-piece" bulb and connecting capillary tubing of 316 Stainless Steel prevent corrosion from liquids, fumes or vapors. Needs no protective tubing. Tightly sealed 5" aluminum alloy case. Available in standard ranges to 1000°F. Easy-to-read scale 12" long. Write for details. The Foxboro Company, 4611 Norfolk Street, Foxboro, Mass., U.S.A.

FOXBORO
Reg. U. S. Pat. Off.
DIAL THERMOMETERS

extractors show a minimum specific-gravity difference of 0.121 and a maximum of 0.241, which is in the range in which inter-face floats can operate.

The gravity difference of the layers changes with stock changes and solvent treating conditions. The extractors apparently have enough over-design factor so that they can operate for an interval without any visible layer separation in the extractors in the middle of the system. This cannot go on continuously, but can persist for a period of time. For example, the level will first disappear in the extractor where the oil charge is introduced because the oil concentration here is greatest and the gravity difference the least. By experience, the operator knows his valve setting for a normal transfer from this compartment. When the level disappears by solution of the two layers, he does not change the rate of transfer from the compartment but watches the next level down the line to get his trend. An instrument would indicate that the transfer should be stopped until the level reurned. This cannot be done because the other extractors down the line would starve and the transfer to the recovery unit would be interrupted. This could not be tolerated in a system as closely coupled as the Duo-Sol plant where surge holdup is a minimum and exchange is used to a maximum. Flow interruption from the extractor would upset the whole plant in minutes. You may wonder how the extractor operation continues under these conditions. It is because there is enough internal circulation capacity that, when one extractor is not functioning properly, the others on each side pick up the load until they become overloaded. These conditions can be corrected by change in extractor temperature or reduction in oil charge but, as explained, the extractor-to-extractor transfer must continue in order to avoid a complete plant upset.

Inter-face floats were tried, but were not satisfactory because of the reasons given. An improved displacement float also was tried. This float had no control function but was used as an indication to the operator that he might be headed for trouble. It was installed on the No. 1 extractor, where the gravity difference is the greatest and where the extractors have to be in complete solution before the interface level disappears. This installation has done a good job and has always indicated the level trend in this extractor. It would be interesting to move the float to the critical No. 3 extractor. It is doubtful that a fully instrumented extractor system would eliminate an operator.

METER SEALS

The last point has to do with the meter-seal system which was originally designed and installed in the dewaxing plants. This system was to be a purge system using recovered solvent. The solvent source selected was theoretically clean solvent. In practice, however, the solvent contains small quantities of wax so that before long the meter lines were plugged by an accumulation of wax which gradually settled out of the solvent. Efforts were made to make the solvent purge system work, but finally it was abandoned; the meters were sealed with conventional sealing fluid and lead lines and pots were steam traced.

If mercury-less differential-pressure meters had been as advanced at the time Cit-Con was designed as they are now, it is possible that this type of meter would have been used to eliminate many difficult sealing jobs.

DISCUSSION

Discussor: What do you do to prevent sweating in finished product tanks?

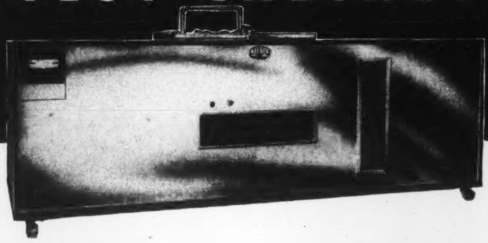
Midlam: We have air dryers on the finished oil storage tanks. They consist of twin "Lectro-dryer" units. In 2½ years we have never had a wet sample to be shipped out.

Question: About the rotameter on a stream at high temperature on the Duo-Sol unit, why wouldn't an orifice meter work on that stream?

Midlam: I think that the necessary correction for gravity and viscosity would enter into the problem for an orifice meter; I don't believe it would have the accuracy that the rotameter has with our blocked operation. The troublesome sealing problem also is eliminated with the rotameter.

WEBBER LOW-TEMPERATURE

TEST CABINET



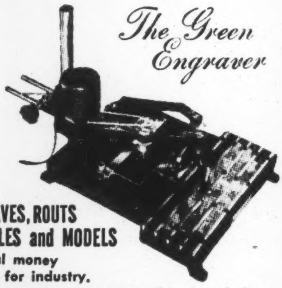
★ The Webber Low Temperature Test Cabinet illustrated is a standard 9 cubic foot unit with terminal panel added for electrical connection to the inner chamber for testing of electrical equipment. The temperature range is from ambient to —125°F., with a very rapid pull-down time. Temperature can be accurately controlled at any point in the temperature range. Temperature is controlled by a visible type indicating controller with a scale range from —200° to +200°F. Recording temperature controller is available as optional equipment. The freezing chamber will withstand impact loading of 1200 pounds per square foot and uniform distribution static loading of 2,000 pounds per square foot. This prevents damage caused by dropping heavy objects in storage compartment. Available as optional equipment are combination air and water cooled compressors and roller-bearing swivel type casters. There's a Webber Unit for every industrial need.

Write for new bulletin giving more complete information.

INDUSTRIAL FREEZER DIVISION
WEBBER APPLIANCE CO., INC.
2740-D MADISON AVENUE • INDIANAPOLIS 3, INDIANA

ENGRAVING and MARKING

The Green Engraver



ENGRAVES, ROUTS PROFILES and MODELS

A real money saver for industry.
Proven by the experience of tool and die, electronic machine, radio, electrical and instrument manufacturers.

DIAL STENCIL

DIRECTIONAL SIGN

BARREL DIAL

The Green Engraver zips out precision work on metal, plastics, wood, glass, hard rubber etc. . . . engraves panels, name plates, scales, dials, molds, lenses, instruments, instruction plates, directional signs . . . by simple tracing. *Routing, profiling and three dimensional modeling indicate its versatility.* Electric etching attachment available.

Specify the Green Engraver for the best in low cost performance.
Special attachments and engineering service available for production work.

FREE — Fact-packed folder yours upon request.

Green Instrument Co.

383 Putnam Avenue **Cambridge 39, Mass.**

Brackets can be furnished for attaching furnace to column as shown above.
Tensile test type of Marshall furnace is shown at right.

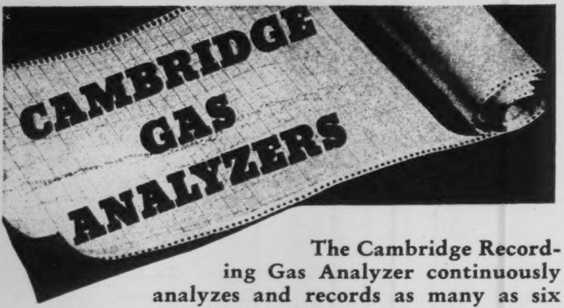
Laboratories of the stainless steel industry, automotive and aircraft industries, metal refining, and atomic energy research are all users of the Marshall tubular furnace for tensile, creep or stress-rupture tests.

These research engineers express a high degree of satisfaction with the results of using this equipment. They find that temperature of the heating chamber in Marshall furnaces can be maintained with a uniformity within plus-or-minus 3° F, and in some cases within 1° F. Furnaces are available in "Creep Test" type and "Tensile Test" type. Write for literature.

MARSHALL PRODUCTS CO.
270 W. LANE AVE., COLUMBUS 2, OHIO

Marshall **furnaces**

AND CONTROL PANELS



The Cambridge Recording Gas Analyzer continuously analyzes and records as many as six constituents of a gas. Eliminates intermittent, slow and expensive manual gas analysis. Accurate . . . Sensitive . . . Simple. No moving parts; utilizes thermal conductivity principle.

Makes possible substantial savings in the operation of kilns, production of inert gases, and in metallurgical, petroleum, and other chemical processes. Single- and Multi-point instruments are available for a wide variety of applications.

Send for literature mentioning application

CAMBRIDGE
INSTRUMENT COMPANY, INC.
3742 Grand Central Terminal, New York 17
Pioneer Manufacturers of
PRECISION INSTRUMENTS

MARSHALLTOWN
DIAL THERMOMETERS

New
STAINLESS STEEL
BULB
AND NUT
80
90
100
70
110
60
120
50
130
40
°F
140

THE COMPLETE LINE

Now furnished in stainless steel bulb and nut, Marshalltown dial thermometers are accurate, compact, durable instruments for the indication of liquid or gas temperatures. They are available in a variety of temperature ranges from minus 40° F. to plus 500° F. Actuation is positive, direct with full freedom — no gears or pinions. Available in sizes 2", 2½", 3½" and 4½".

WRITE TODAY FOR FULL DETAILS AND PRICES

Marshalltown Mfg. Co., Marshalltown, Iowa

Discussor: With orifice meters on high-viscosity materials, have you been able to improve accuracy due to viscosity effects on the orifice?

Midlam: It could possibly be taken care of by higher range tubes. Another thing we have done is draw a series of curves which correct for viscosity and temperature so that when feed tanks are switched the operator can maintain correct solvent ratios.

Midlam: The question was asked as to what happened in the MEK system if the solvent flow was lost completely? In that case the relay which was shown in Fig. 3 gets its impulse from the transmitted air on solvent flow of the ratio controller; the relay is set so that if the air falls below a certain point, the relay shuts off the flow of oil to the chillers.

Discussor: Mr. Close, of Fluid Control Co. wants to know if you measure viscosity in pipe lines in your plant?

Midlam: The only control of viscosity that we have is to adjust the viscosity of the streams from the vacuum unit. This is done by experience. We do little or no blending for viscosity. With this method we finish 200 viscosity from one stream, 350 viscosity from another, etc.

Discussor: Joe Lyles of Carbide wants to know details on starting up the auxiliary compressor on the Duo-Sol.

Midlam: The primary action for that starter is through a mercury "Mercoid" control system which actuates an across-the-line starter to start the compressor up right across the line; in a few seconds it goes over to normal automatic control.

PROCESS FLOW SHEETS

Continued from page 1567

Another method that may simplify process flow and control sheets is to designate heat exchangers or condensers in such a way that the person reading the flow sheet knows what flowing medium is on the shell side and what is on the tube side. This is done by using a dotted line within the exchanger or condenser circle to indicate flow through the tubes. The water flow through a cooler usually is indicated by an arrow diagonally upward through the cooler symbol from left to right.

Another common use of process flow sheets is in the preparation of "flag sheets" which show the important operating variables on an operating unit. This data includes flowing medium, gravity, temperature, and pressure at important points throughout the unit. The data is recorded from actual operation and serves as a record for study by operating personnel, executives, and others interested in unit operations. Due to the limited amount of time that such people have available for studying all operations it is desirable that only essential information be presented on the "flag sheet." A simplified process flow sheet is ideal for this purpose.

DISCUSSION

Discussor: How much instrument information do you include on control diagrams?

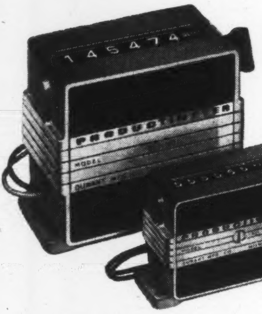
Willoughby: On new construction or any unit that is in the process of being changed over, each individual application is sketched on a sheet of 8½ x 11 which gives the pipe fitter and the instrument men all the necessary information in regard to fittings and everything that goes with the application.

Discussor: Do you make use of the I.S.A. Instrument Symbols?

Willoughby: We have not had a complete discussion on the I.S.A. Symbols. However, we have what we consider pretty good symbols. We use those. However, as each man has his own idea and his own symbols, it would be a good idea if we could agree on standard symbols.

Mr. Harvey, Dow Chemical: How do you show electric instruments in interlocks on instrument diagrams?

Willoughby: On units where there are several of these interlocks, we use a separate print showing the wiring diagram.



2 ELECTRIC PRODUCTIMETERS

"CS" and "Y"
ELECTRIC PRODUCTIMETERS
The answer to all electric counting requirements

Two Companion Counters . . . Two Sizes . . .
Hi-Speed . . . Accurate . . . Long Life . . . Totally Enclosed

Speeds of 1000 counts per minute. Both counters give maximum readability. Design fits all mounting conditions . . . panel mounting or base mounting. Hardened steel working parts for long life and dependability.

New type case for compactness, rigidity, and protection against dust and moisture conditions. Operate accurately over wide current fluctuations.

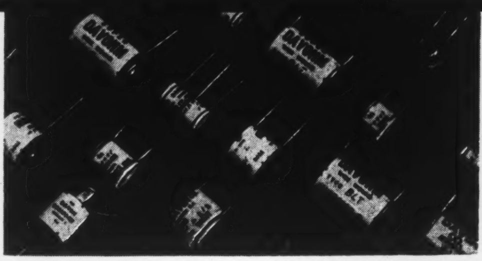
Write for "New Electrics" Bulletin

DURANT MANUFACTURING CO.
1914 N. Buffum St.
Milwaukee 1, Wis.
114 Orange St.
Providence 3, R. I.
Representatives in Principal Cities

PRODUCTIMETERS
SINCE 1879 *Count Everything*

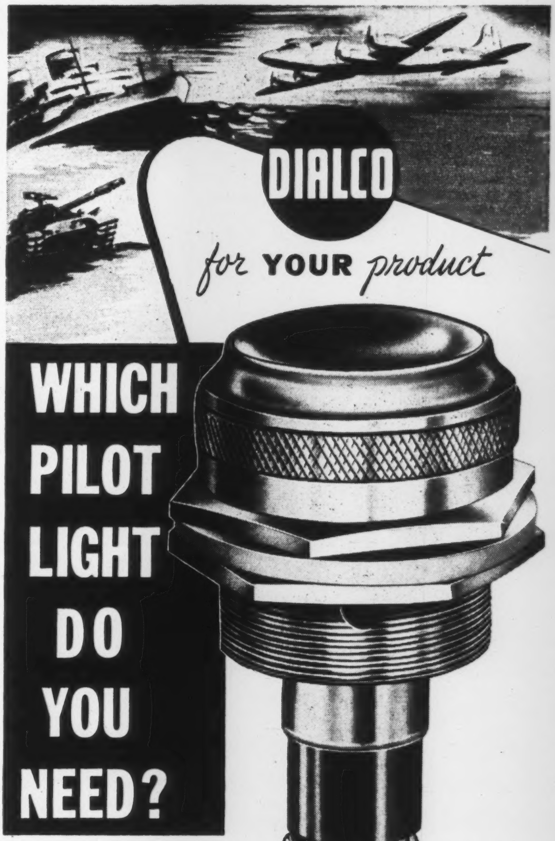
Don't Say Resistors

Specify **DAVOHMS**
The Complete, Superior Line of Precision
WIRE WOUND RESISTORS
Made Only By **DAVEN**
ELECTRONIC SPECIALISTS FOR MORE THAN A GENERATION



- Accuracies to .05%
- All Temperature Coefficients
- All Types of Mountings
- Hermetically Sealed Types
- Manufactured to Famous Daven Standards of Precision
- EXCELLENT DELIVERIES

Write for detailed bulletin
THE DAVEN CO.
175 Central Avenue • Newark 4, N. J.



WHICH PILOT LIGHT DO YOU NEED?

ACTUAL SIZE
Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

or

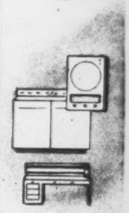
ACTUAL SIZE
Cat #8-1930-621

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

Dialco HAS THE COMPLETE LINE of INDICATOR and PANEL LIGHTS

Samples to suit your own special conditions and requirements will be sent promptly and **without cost**. Just outline your needs Let our engineering department assist in selecting the **right lamp** and the **best pilot light** for YOU.



Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

The DIAL LIGHT COMPANY of AMERICA
60 STEWART AVENUE, BROOKLYN 37, N. Y. HYACINTH 7-7600

TYPE B
HIGH PRECISION
POTENTIOMETER

This instrument, incorporating a number of notable refinements in potentiometer design, is widely used in chemical laboratories for solution-electrode potential measurements, for highly accurate thermocouple measurements, and for other critical measurements of DC potentials requiring exceptionally high accuracy. Distinctive features include:

1. Three ranges: 0 to 1.6 volts, 0 to 160 millivolts and 0 to 16.1 millivolts.
2. Three reading dials—effective scale length of approximately 175 feet for each range. Readings easily estimated to within one part in 100,000 of full-scale ranges.
3. Subpanel switch and slidewire construction for protection of contacts from dust and corrosive fumes.
4. Special provisions to minimize parasitic thermal emf's—including automatic compensation of slidewire thermals and gold contacts in galvanometer key.
5. Exceptional convenience in reading and adjustment.
6. Solid and substantial construction for many years of trouble-free service. Thoroughly proven by practical application in exacting research investigations for nearly fifteen years. Described in Bulletin 270 with other Rubicon potentiometers, including the popular portable precision models.

Rubicon galvanometers suitable for use with the type B potentiometer are listed in Bulletin 320.

OTHER RUBICON PRODUCTS

Galvanometers • Resistance Standards • Wheatstone, Kelvin and Mueller Bridges • Evelyn Photoelectric Colorimeter for precise colorimetric chemical analysis • Automatic Recording Photometric Analyzers for NO and H₂S • Magnetic Permeameters • Other equipment involving precise measurement of electrical quantities.

RUBICON COMPANY
Electrical Instrument Makers
3755 Ridge Avenue • Philadelphia 32, Pa.

continued from page 1575

Potentiometer Recorders

The potentiometer recorder, or *d-c. millivolt recorder* (Fig. 14-19) has a circuit similar to that of the bridge recorder except that the input circuit balances potentials rather than resistances or reactances. Note that Figs. 14-18 and 14-19 are alike except for the input circuit.

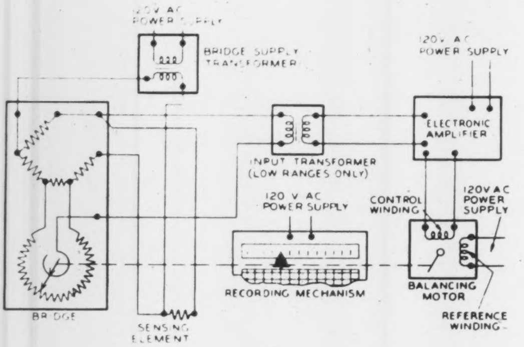

120V AC
POWER SUPPLY
BRIDGE SUPPLY
TRANSFORMER
120V AC
POWER SUPPLY
ELECTRONIC
AMPLIFIER
INPUT TRANSFORMER
(LOW RANGES ONLY)
120 V AC
POWER SUPPLY
CONTROL
WINDING
120V AC
POWER
SUPPLY
RECORDING MECHANISM
BALANCING
MOTOR
REFERENCE
WINDING
BRIDGE
SENSING
ELEMENT

Fig. 14-18. Bristol "Dynamaster" bridge recorder.

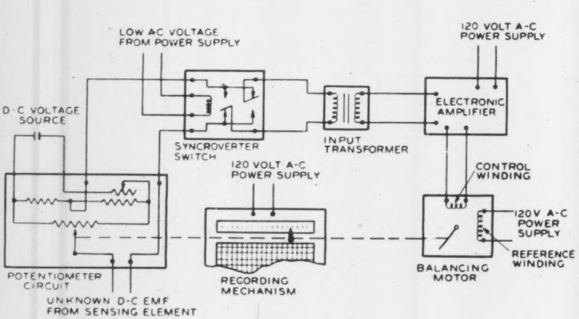

LOW AC VOLTAGE
FROM POWER SUPPLY
120 VOLT A-C
POWER SUPPLY
D-C VOLTAGE
SOURCE
SYNCROVERTER
SWITCH
INPUT
TRANSFORMER
ELECTRONIC
AMPLIFIER
120 VOLT A-C
POWER SUPPLY
CONTROL
WINDING
120V A-C
POWER
SUPPLY
REFERENCE
WINDING
BALANCING
MOTOR
POTENTIOMETER
CIRCUIT
RECORDING
MECHANISM
UNKNOWN D-C EMF
FROM SENSING ELEMENT

Fig. 14-19. Bristol "Dynamaster" potentiometer, or millivolt recorder.

In the d-c. millivolt recorder, the unknown d-c. potential is balanced out by a known potential obtained from a battery across a rheostat. This battery circuit is standardized against a standard cell at intervals to assure that the balancing potential is known accurately. Fig. 14-20 shows a thermocouple used with the Brown "Electronik" millivolt recorder. Note that the d-c. output of the potentiometer circuit is chopped by a converter so that a-c. amplification can be used. All the bridge recorders mentioned previously are available in millivolt-recording types.

Both bridge and millivolt recorders are in general use. They have many advantages: (1) high impedance (infinite at balance), (2) high sensitivity (nominal input of 0.1 millivolt and smaller if necessary), (3) accuracy of ¼ percent of full scale, (4) fast response—from 10 seconds

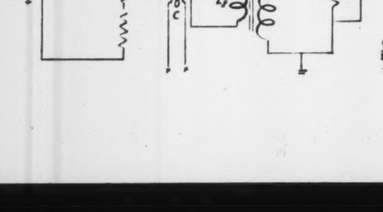
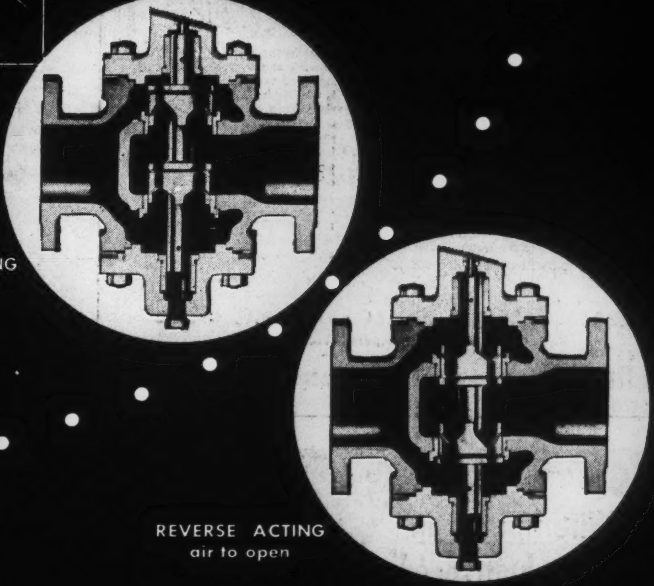

FIRST AMPLIFIER
STAGE
B+
+
E-c
T₁
R₀
E_R
L₁
R_S
REED
A
1
2
B
L₂
C
-

Fig. 14-20. Input circuit of Brown "Electronik" millivolt recorder used with thermocouple.

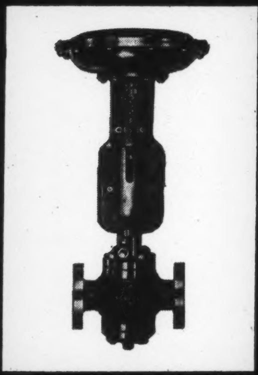
QUICK SHIFT



DIRECT ACTING
air to close

REVERSE ACTING
air to open

for easy field reversal of valve action



You can reverse the control action of the Honeywell Series 700 Valve by inverting the valve body and disc, and turning the travel indicator plate to its reverse side. It can be done in the field . . . easily and quickly, without extra parts or complex adjustments.

The Honeywell Series 700 wide band proportional control valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division,* 1908 Windrim Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
VALVE PRODUCTS

H
HONEYWELL

First in Controls

IF it's a problem in Precision Potentiometers

...Helipot

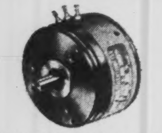
HAS THE ANSWER!

World's largest manufacturer of precision potentiometers

HELIPOT offers a unique combination of unequalled "know-how", advanced manufacturing facilities and experienced personnel for solving *your particular* problems in the application of precision potentiometers to modern electronic circuits.

Suppliers to both Government and industry, HELIPOT has developed high speed winding, assembling and testing equipment that combine custom-built precision with mass-production economies. Multiple and single-turn designs ... single and double shaft extensions ... ganged assemblies ... custom-spaced taps...multi-turn dials...*these and many other special features are part of the daily output at* HELIPOT!

If you have a problem requiring precision potentiometers, bring it to HELIPOT Corporation—*world leader in its field*. A call or letter outlining your problem will receive immediate attention!



First in the field with *ball bearing* shaft supports as a standard production feature is the Model J Helipot. The single-turn "J" offers 1 oz. starting torque, continuous rotation, 3-way servo mounting, custom taps, 5 watts power rating, 50 to 50K ohms resistance, ±0.5% linearity. As many as 6 units can be mounted on one shaft and *independently phased after installation*. Send for complete data.

REPRESENTATIVES IN ALL PRINCIPAL CITIES

Export Agent: Frathom Co., New York 18, N. Y.

THE Helipot CORPORATION • SOUTH PASADENA 11, CALIFORNIA

Wire finer than human hair speeds bulk weighing

Built into this 150 ton crane hook is a Baldwin SR-4® Load Cell that speeds and simplifies weighing of bulk materials. As loads vary, strains are transmitted to a compression member inside the Load Cell and in turn to a grid of very fine wire. As length of the wire is changed, resistance changes . . . and weights can be measured with an accuracy, speed and safety impossible with more conventional systems.

If you are interested in crane weighing, batch weighing, or any other type of weighing, you'll find Baldwin Load Cells offer a unique solution. Other SR-4 devices can solve your problems in measuring torque, pressure, explosions, etc.

BALDWIN-LIMA-HAMILTON

Testing Headquarters—Philadelphia 42, Pa.

In Canada: Peacock Bros. Ltd., Montreal, Quebec

to ¼ second full-scale, (5) easily changed in range for high versatility, and (6) small maintenance.

CONTROLLERS

Modern controllers for industrial processes have proportional, reset, and rate responses so that effective control can be maintained despite capacity and transfer lags in the process. Electronic controllers are available with these responses and with electric-to-pneumatic converters on the output for driving diaphragm-motor valves.

Fig. 14-21 shows the electronic controller of Leeds & Northrup. The control slidewire is the null-seeking slidewire in the bridge-type recorder (which is not shown). This in turn is in a bridge circuit with another "valve slidewire" attached to the control valve. The amplifier for control of the "control slidewire" is not shown. Any unbalance between the control slidewire and valve slidewire causes an output signal that energizes the valve operator. However, the response of the valve operator to change in error signal is adjustable in the three basic modes of operation.

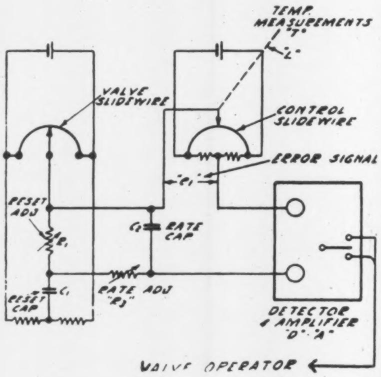

TEMP. MEASUREMENTS "T"
"L"
VALVE SLIDEWIRE
CONTROL SLIDEWIRE
ERROR SIGNAL
"e1"
RESET ADJ
R1
C2
RATE CAP
C1
RESET CAP
RATE ADJ "R3"
DETECTOR & AMPLIFIER "D"·"A"
VALVE OPERATOR

Fig. 14-21. Leeds & Northrup electronic controller.

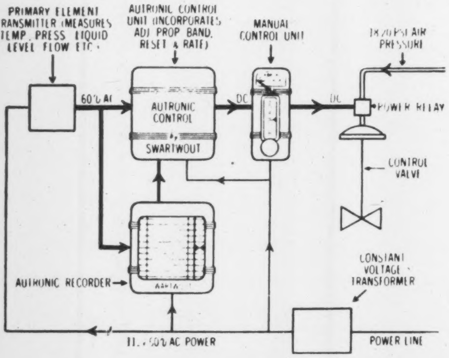

PRIMARY ELEMENT TRANSMITTER (MEASURES TEMP. PRESS. LIQUID LEVEL FLOW ETC.)
AUTRONIC CONTROL UNIT (INCORPORATES ADJ PROP BAND, RESET & RATE)
MANUAL CONTROL UNIT
18/20 PSI AIR PRESSURE
60~ AC
AUTRONIC CONTROL by SWARTWOUT
DC
DC
POWER RELAY
CONTROL VALVE
AUTRONIC RECORDER
CONSTANT VOLTAGE TRANSFORMER
115 60~ AC POWER
POWER LINE

Fig. 14-22. Swartwout miniature electronic control system.

Fig. 14-22 is a block diagram of the miniature electronic control system of Swartwout, showing how the control system is used with an electric-to-pneumatic relay for driving diaphragm-motor control valves.

ACKNOWLEDGMENT

Figs. 1, 2, 4, 5, 8, 9, 10, 11, 12, 13, and 14 are from the book *Mechanical Measurements by Electrical Methods* by Howard C. Roberts.

TEST ITEMS FOR—XIV. SCIENTIFIC AND INDUSTRIAL INSTRUMENTS

14-1. A transducer is a device which
- (a) changes resistance
- (b) changes reactance
- (c) changes form of energy
- (d) changes signal amplitude

14-2. Which of the following is a resistive pickup?
- (a) Thermocouple.
- (b) Strain gage.
- (c) Piezoelectric crystal.
- (d) All the above.

EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

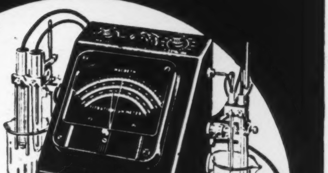
All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

**Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.*

BULLETIN No. 3 ON REQUEST

THE EPPLEY LABORATORY, INC.
SCIENTIFIC INSTRUMENTS
NEWPORT, RHODE ISLAND, U. S. A.



Macbeth
instruments

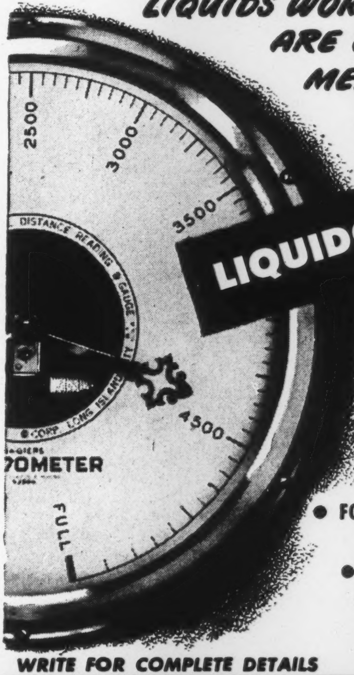
Titration-pH Meter

Line operated, direct reading, continuously indicating. Two instruments in one. Two separate electrode systems. May be operated either as a pH meter or a Titration meter without interfering with the adjustment of either section. Built-in voltage regulation.

Write for Bulletin 153

MACBETH INSTRUMENTS
Laboratory Type pH Meter
Titration-pH Meter
Industrial pH Meter
Explosion-Proof pH Meter
Color Densitometer

MACBETH INSTRUMENT CORP.
a subsidiary of the
MACBETH CORPORATION
NEWBURGH, NEW YORK



"LIQUIDS WORTH STORING ARE WORTH MEASURING"

with a

LIQUIDOMETER

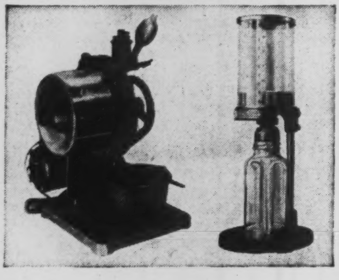
Tank Gauge

- FOR GAUGING LIQUIDS OF ALL KINDS
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES

WRITE FOR COMPLETE DETAILS

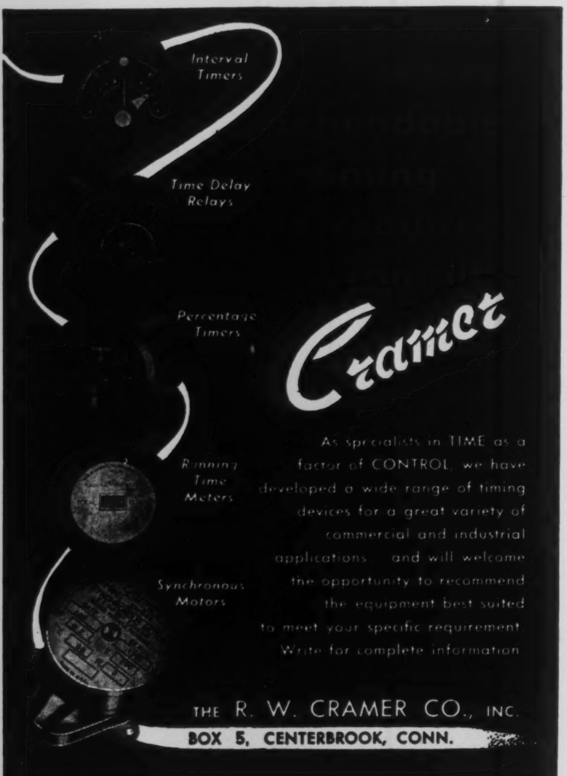
THE **LIQUIDOMETER** CORP.
36 27 SKILLMAN AVE., LONG ISLAND CITY, N. Y.

Complete
MERCURY
Service
★We manufacture for your use
BETHLEHEM OXIFIERS and FILTERS



★★We sell
INSTRUMENT MERCURY
—in the handy "squeeze" bottle
Highest quality—reasonably priced

★★★We buy Mercury
Send for full information
BETHLEHEM APPARATUS CO., INC.
887 Front St. Hellertown, Pa.



As specialists in TIME as a factor of CONTROL, we have developed a wide range of timing devices for a great variety of commercial and industrial applications and will welcome the opportunity to recommend the equipment best suited to meet your specific requirement. Write for complete information

THE R. W. CRAMER CO., INC.
BOX 5, CENTERBROOK, CONN.

14-3. Which of the following is a potential-type pickup?
(a) Thermocouple.
(b) Piezoelectric crystal.
(c) pH electrode.
(d) All the above.

14-4. A series circuit for a resistive pickup differs from a bridge circuit in that the former
(a) can be energized by a.c. or d.c.
(b) has zero current at measurement point
(c) is simpler and less expensive
(d) is insensitive to lead-resistance change

14-5. The bridge circuit usually uses two pickup elements in order to
(a) double the output
(b) cancel drift
(c) reduce cost
(d) eliminate the source potential

14-6. The Kelvin bridge differs from the Wheatstone bridge in that the former is
(a) excited by d.c. or a.c.
(b) balanced at measurement
(c) more sensitive
(d) used with high-resistance pickups

14-7. The advantage of resistive pickups over capacitive pickups is
(a) higher stability
(b) higher sensitivity
(c) a-c. operation
(d) all the above

14-8. The advantage of capacitive pickups over resistive pickups is
(a) higher impedance
(b) greater simplicity
(c) simpler measuring circuit
(d) higher sensitivity

14-9. The advantage of bridge circuits over oscillator circuits for measuring capacitance change is
(a) higher stability
(b) higher sensitivity
(c) higher frequency of operation
(d) all the above

14-10. Most inductive pickups operate by changing the
(a) reluctance of their magnetic paths
(b) number of turns in their coils
(c) turns ratio in their coils
(d) ohmic resistance of their windings

14-11. With any type of pickup, the advantage of push-pull output is
(a) higher stability
(b) higher sensitivity
(c) higher linearity
(d) all the above

14-12. Velocity-type inductive pickups differ from other inductive pickups in that the former use
(a) a stationary magnetic field
(b) two coils which change separation
(c) magnetic paths which change reluctance
(d) only one coil

14-13. The advantage of a low-impedance pickup over a high-impedance pickup is that the former requires
(a) less shielding
(b) less amplification
(c) less-stable power supplies
(d) all the above

14-14. The output of very high-impedance pickups such as pH electrodes and ionization chambers is of the order of
(a) micromicroamperes
(b) microamperes
(c) milliamperes
(d) amperes

14-15. The advantage of chopper-type d-c. amplifiers over direct-coupled types is that the former have
(a) noise-free converters
(b) a-c. amplifier stages
(c) fewer components
(d) no power supply

14-16. The ultimate minimum noise level of an amplifier is determined by
(a) microphonics
(b) static
(c) thermal noise in the input
(d) tube noise in all stages

14-17. The noise level of an amplifier can be reduced by
(a) reducing the bandwidth
(b) keeping the input impedance low
(c) reducing microphonics
(d) all the above

14-18. The bridge-type electronic recorder differs from the potentiometer type in that the former
(a) is a servo-operated device
(b) is used with resistive pickups
(c) has a balancing motor
(d) is more complicated

14-19. The basic difference between bridge and potentiometer electronic recorders is the
(a) input circuit
(b) amplifier circuit
(c) balancing motor
(d) recording mechanism

14-20. Modern electronic controllers for industrial processes with difficult transfer and capacity lags have
(a) proportional response
(b) rate response
(c) reset response
(d) all the above

BLAST FURNACES

continued from page 1571

The shell can be drilled and tapped to receive a standard pipe bushing which is welded to the outer end of the protecting tube. Some manufacturers offer a saddle which can be welded to the furnace shell, the saddle having a beveled seat around the insertion hole. A tapered plug is tapped with a standard pipe tap and the protecting tube is chased with three to four inches of thread so as to permit adjustment of the tapered plug on the tube for depth of insertion. The thermocouple then is secured by wedges that hold the plug in the saddle. A more-flexible variation is to weld a three-by-four-inch collar to the shell and a four-bolt flange to the outer end of the collar. A companion flange is used instead of a plug or bushing on the protecting tube and can be securely bolted to the fixed flange on the collar.

The thermocouple hot junction can be located either at a fixed distance from the outer surface of the shell or with minimum thickness of brickwork between the hot junction

"X-ray Diffraction has been of major assistance in developing catalytic processes for the production of aviation fuel from crude petroleum and for the conversion of coal or natural gas to gasoline; it has also guided us in the development of the new chemically resistant plastic — KEL-F."

W. E. Hanford

Vice President

THE M. W. KELLOGG COMPANY

Synthetic Motor Fuels—New Plastics Thanks to the *Atomic "Third Degree"*

NORELCO X-ray Diffraction, X-ray Spectrometry, Fluorescence and Absorption Analysis equipment provide American industry with an atomic "third degree," enabling leaders to improve present products, develop amazing new ones.

NORELCO X-ray Diffraction equipment is the new non-destructive research tool that permits results impossible for the cruder methods of traditional chemistry. It is the basic laboratory tool through which scientists probe the atomic structure of materials. It is an industrial tool for process control and product development.

NORELCO X-ray Diffraction equipment may be the missing link in your own research process. Ask for a free consultation at Philips Applications Laboratories. Meantime, send for free booklet: "What is X-ray Diffraction?"

Serving Science and Industry

Typical Users

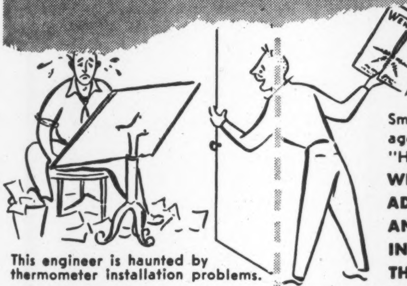
California Institute of Technology
Gulf Research & Development Company
Monsanto Chemical Company
North American Aviation, Inc.
Pacific Coast Borax Co.
Phillips Petroleum Company
Sinclair Refining Company
Sprague Electric Company
Standard Oil Company (Indiana)

A **Norelco** PRODUCT OF NORTH AMERICAN **PHILIPS** COMPANY, INC.

Dept. IM-11 • 100 East 42nd St., New York 17, N. Y.

In Canada: Rogers Majestic Electronics Ltd., 11-19 Brentcliffe Road, Leaside, Toronto 17, Ontario

The Case Of The Haunted Engineer

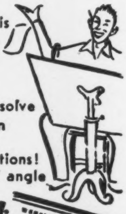


This engineer is haunted by thermometer installation problems.

WEKSLER N.Y.C.

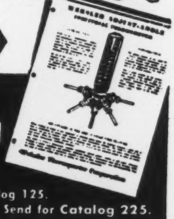
Smart purchasing agent suggests: "How about: **WEKSLER ADJUST-ANGLE INDUSTRIAL THERMOMETERS?"**

"Hello, **WEKSLER?"** Engineer goes into action! "Send over plenty of **ADJUST-ANGLE INDUSTRIAL THERMOMETERS!"**



The bottleneck spell is broken. **WEKSLER ADJUST-ANGLE INDUSTRIAL THERMOMETERS** solve all plant installation problems without complicated calculations! They adjust to ANY angle through a 180° arc!

Today—find out how WEKSLER can make things smoother in YOUR plant! Ask your jobber for Important Free Bulletin AA50 or write to:



"Industrial America's Right Arm"

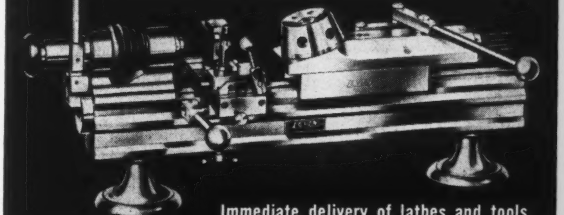
WEKSLER THERMOMETER CORPORATION

Martinique Bldg

49 W. 32nd St., New York 1, N. Y.

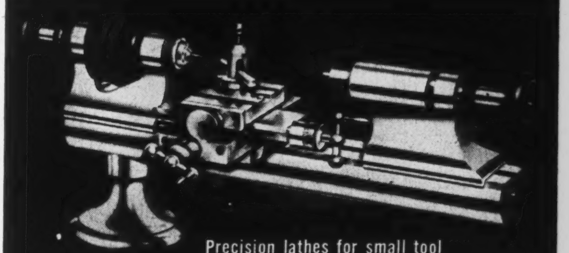
For Industrial Thermometers Send for Catalog 125.
For Glass Engraved on Stem Thermometers and Hydrometers, Send for Catalog 225.
For Dial Indicating and Recording Pressure Gauges, Send for Catalog 525.
For Dial Indicating and Recording Thermometers, Send for Catalog 325.

Collet capacity $\frac{3}{16}$" or $\frac{5}{16}$", swing 4", bed 18" long, 6 position self-indexing turret with ½" holes.



Immediate delivery of lathes and tools.

LEVIN® Jewelers type lathes for fine instrument work and second operations. Collets as small as .004". Send for catalog. Louis Levin & Son, Inc., 782 E. Pico Blvd., Los Angeles 21.



Precision lathes for small tool and instrument work. Complete line of accessories.

RENEW WORN OPTICAL FLATS

Scratched and Worn
(Poor Transparency)
Reconditioned by Acme
(Clear Transparency)

Restore Original Transparency, Accuracy
Acme's Rehabilitation Service restores worn and scratched optical flats to original transparency and accuracy. Flats are re-ground and re-polished, reconditioned like new, at savings up to 40% of the price of a new flat. Service is fast. Write for details, now!

New Optical Flats, Toolmakers Steel Flats, Available
•
All Sizes, All Diameters

Acme Scientific Company
manufacturers of optical flats and monochromatic lamps . . . mold polishing
1452 West Randolph Street • Chicago 7, Illinois

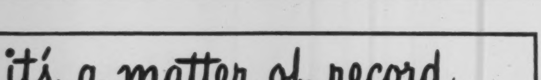
it's a matter of record

YOU CAN COUNT ON... Barcol MOTORS in STREETER-AMET RECORDERS

In Mechanical Recorders (units that count impulses, and record the count at selected intervals) made by Streeter-Amet Co. of Chicago, high-torque Barcol Motors provide a powerful, compact, low-input source of power to drive the tape and printing ribbon advance mechanisms, also the printing hammer release and the counter wheel reset.

BARCOL MOTORS: Unidirectional, synchronous, and reversible motors — with or without reduction gearing — open or enclosed types — up to 1/30 HP. Engineering service available.

WRITE FOR LATEST CATALOG DATA



Streeter-Amet Mechanical Recorder. Right, mechanism with case removed, Barcol Motor in circle.

BARBER-COLMAN COMPANY
1219 ROCK STREET • ROCKFORD, ILLINOIS

and the stock. The former will better reflect changes of long duration, such as the gradual wearing of the lining; the latter will reflect changes or inequalities occurring at a common distance from the hot junction. However, the depth of insertion into the brickwork determines not only the rate of response to temperature change but also the rate of deterioration of the measuring element. An insertion depth of less than 12 inches is not satisfactory for determining useful lining life remaining.

With regard to the use of temperature measurements to detect channeling of gases or stock, the channeling frequently is not near the inner face of the inwall; furnace movement is a more reliable indication. Scab formation, if pronounced, affects stock movement and should change the inwall temperature. However, with modern mechanical distributors and well-designed furnace lines, channeling and scab formation do not occur frequently.

Daily observations of inwall temperatures should be made by blast-furnace personnel, and efforts should be made at correlating temperature with other variables in operation. Valuable information can be obtained by plotting average weekly temperatures of each inwall thermocouple so that variations can be noted readily. Spot observations of temperatures are meaningless. Note, however that the temperatures do have meaning as far as wall thickness is concerned if the temperature variation between two locations is 50 deg. F or over; this assumes normal conditions of stock distribution and movements. It must be remembered that periodic replacements of thermocouples should and can be made if properly scheduled with regular maintenance stops. Close cooperation is required between the instrument service department and the operating department.

RECORDERS

Highly reliable recording instruments are available for recording the inwall temperatures from one or a battery of thermocouples. Little maintenance is required and calibration checks need be made as infrequently as once every three months. Although the author prefers strip-chart recording pyrometers over circular-chart models, the charts of the latter can be conveniently filed for reference. A multi-point recorder of six points is suggested, but additional recorders are required for more complete temperature data from the inwall. Use of more than a six-point record on standard recorders results in the overlapping of the printed curves. Special recorders can be supplied with a double range and two complete measuring systems printing on a single chart. Electronic instruments of the multi-point printing type are available which scan and print temperatures of six thermocouples in less than a minute. This speed is not required; a speed of one minute per point is adequate.

A simpler installation can be made with an indicating millivoltmeter pyrometer, high speed, with a manually operated scanning switch. With these instruments it is possible to read as many points as there are points on the selector switch. Only the best selector switch should be used because serious errors in reading can be caused by poor contacts in the measuring circuit. The stove or hot blast man can easily record as many as eighteen temperatures hourly by this method, and in two or three minutes.

As blast-furnace operating people generally agree upon the benefits to be derived from the use of inwall temperature measurements, it seems that much information that has been and is being recorded might be assimilated in more intelligible form. Instrumentation in the past ten years may have outstripped the ability of consumers to realize full benefits from it. To obtain these benefits requires advance preparation in assigning people to observe and apply the instruments to the fullest benefit of the operation.

"Heat Inertia" in Problems of Automatic Control of Temperature
By Victor Broida
Stiff paper, 64 pages. $1.00 postpaid
Instruments Publishing Co.
921 Ridge Ave. Pittsburgh 12, Pa.

The "manufacturer's" gauge—

For years Marsh Gauges have been first choice of manufacturers of controls and other equipment where pressure indication plays a vital part. Their use on *your* product is a mark of distinction.

The finer construction of Marsh Gauges is not limited to costly types, but is common to the entire line in square relationship to the service for which they are recommended. All—regardless of cost—are *quality* instruments.

Write for this catalog covering the broader Marsh line.

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corp., **DEPT. 42, SKOKIE, ILL.**
Export Dept., 155 East 44th Street, New York, New York

Statement of Ownership

Statement of the Ownership, Management, Circulation, Required by the Act of Congress of August 24, 1912 as amended by the Acts of March 3, 1933 and July 2, 1946 (Title 39, United States Code, Section 233) of *Instruments, The Magazine of Measurement and Control*, published monthly at Pontiac, Illinois, for October 1, 1952.

1. The names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, Richard Rimbach, Pittsburgh, Pa.; Editor, M. F. Behar, Pittsburgh, Pa.; Managing Editor, Richard Rimbach, Pittsburgh, Pa.; Business Manager, Richard Rimbach, Pittsburgh, Pa.

2. The owner is: (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one percent or more of the total amount of stock.) Instruments Publishing Company, Inc., Pittsburgh, Pa.

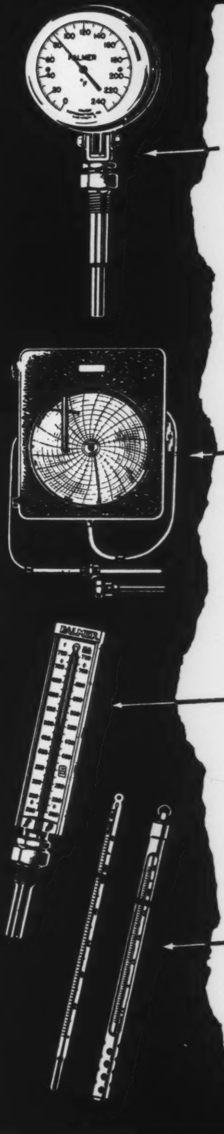
M. F. Behar, Pittsburgh, Pa.; Jackson Burgess, Freeport, Illinois; Freda Seibert, Pittsburgh, Pa.; M. D. Pugh, Altadena, Calif.; Martha B. Rimbach, Allison Park, Pa.; Richard Rimbach, Pittsburgh, Pa.; Richard J. Rimbach, Jr., Pittsburgh, Pa.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Richard Rimbach, Publisher,

Sworn to and subscribed before me this 17th day of September, 1952. Kenneth M. Winterbottom, Notary Public. My commission Expires September 11, 1955.



SINCE 1872 Leading American Industries have depended upon . . .

PALMER

MERCURY ACTUATED
Temperature Indicating Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-case aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury—Extruded brass case—chrome finish. Ranges —40 +950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

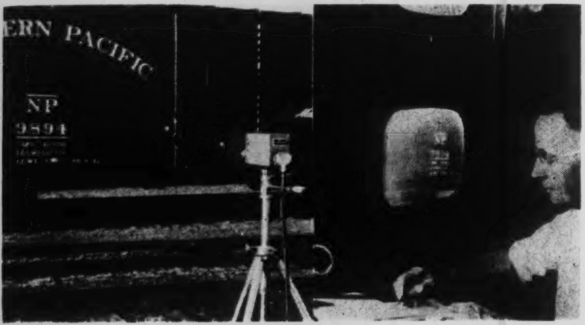
PALMER THERMOMETERS, INC.
CINCINNATI 12, OHIO
Telephone MElrose 1500

INSTRUMENTS ON THE MARCH

New Principles. Applications. Non-commercial Developments

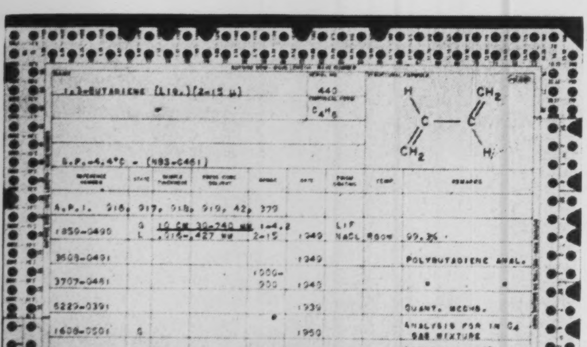
ITV in Railroading

CHICAGO, Ill.—Industrial television was given its first extensive test in the field of railroad operations at the Barr Yard of the B & O Chicago Terminal Railroads. For the demonstration, several industrial television cameras were installed at strategic points throughout the large railroad yard, so that yard operations can be supervised visually from one central location. The cameras were of a type newly developed by RCA Victor, measuring only 3 x 5 x 10 inches.



Card Catalog of Infrared Spectra

WASHINGTON, D. C.—A comprehensive punch-card catalog of all available data on the infrared spectra of organic and inorganic compounds is being set up by the National Bureau of Standards under the sponsorship of the National Research Council. The cards are sorted with a needle by means of the holes and notches on their edges. The compound card carries on its front face empirical and structural formulas, chemical function group, and a complete bibliography on the compound. On its other side are the infrared spectrum of the compound, a table of wave-lengths of the absorption maxima, and a description of the sample from which the data are taken. For each of the references listed on the compound card, there is an abstract card (not shown).



1,3-BUTADIENE (LIQ.)(2-15 μ)

443

C_4H_6

B.P. -4.4°C - (493-0461)

A.P.I. 316, 317, 318, 319, 42, 379								
1850-0495	G L	10 CM 30-740 MM .015-.427 MM		1-4.2 2-15	1949	LiF NaCL	ROOM	99.3%
3603-0491					1949			POLYBUTADIENE ANAL.
3707-0461				1000-900	1949			
6229-0391					1939			QUANT. MEAS.
1606-0501	G				1950			ANALYSIS FOR IN C4 GAS MIXTURE
6384-0492					1949			ACCURACY IN IR ANALYSIS
4431-0461					1948			ABSORPTION FREQ.
7966-0471					1947			ANAL. FOR IN GROUP OF HYDROCARBONS
0923-0441	G	11 CM	74 CM PRESS	4-9	1944	NACL		SPECTRUM; ANAL. FOR IN HYDROCARBONS

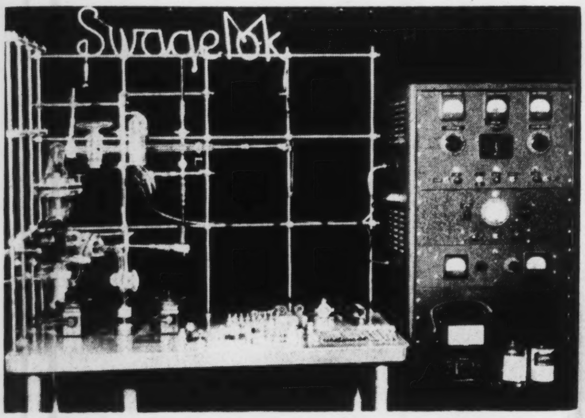
CARD 1 (SEE CARD 2)

Ultra-high Vacuum Demonstrator

CLEVELAND, Ohio.—That the industrial application of ultra-high vacuums is now practical was demonstrated at the Seventh National Instrument Conference and Exhibit on a testing unit developed by William O. Phillips of Cambridge Metal Associates for Crawford Fitting Co., manufacturers of "Swagelok" tube fittings.

Stock "Swagelok" fittings were used in the demonstrator.

Under ideal conditions the combination of a mechanical fore-pump and diffusion pump is capable of 10^{-7} mm. mercury, which is another way of saying that the air pressure in the system can be reduced from the normal 14.7 pounds per square inch absolute to 0.00000000194 psia. Actual practice fell one decimal point short of the ultimate—not because the demonstrated fittings leaked, but because of the demonstrator's great number of stopcocks and ground joints and the vapor pressure of the grease. In other words, the practical limit proved to be 10^{-6} mm. or 10^{-3} micron (a micron is 10^{-3} mm.).

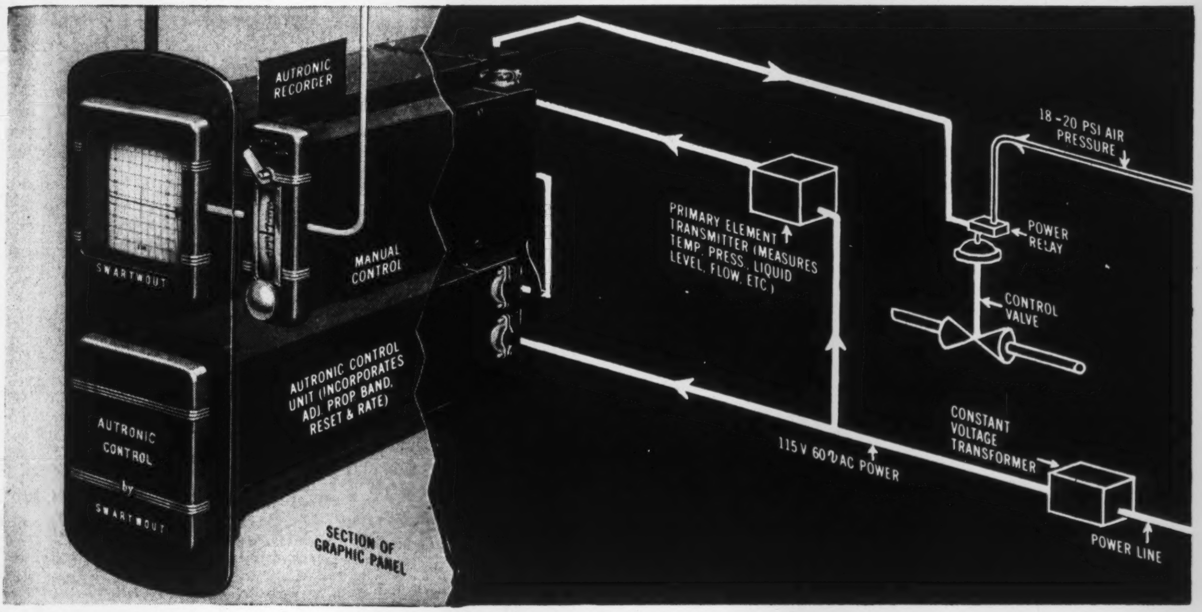


Three measuring gages were used on the ultra-high vacuum tester: (1) a thermocouple-type gage reading from 1000 microns to 5 microns; (2) a Philips gage with a pressure range of 25 to 0.02 microns; (3) an ionization gage, the most sensitive of all, having a range of 10^{-5} to 10^{-8} mm.

New Extensometer

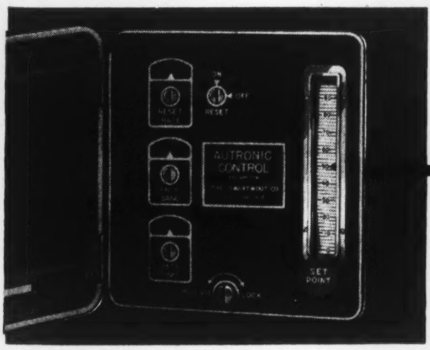
COLUMBUS, Ohio.—An improved extensometer with new time-saving and protective features has been developed by engineers at Battelle Institute, Columbus, Ohio. The extensometer automatically releases itself from the test specimen before the breaking point is reached and without stopping the test. The breakway feature is particularly useful in high-temperature testing operations. License for its manufacture is yet to be issued.

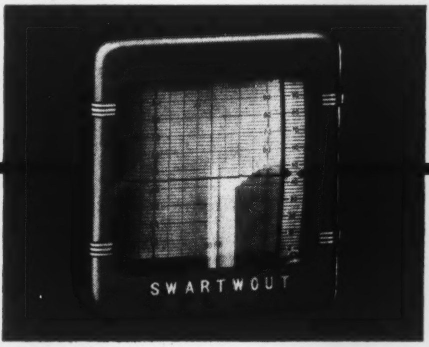
Miniature all-electronic system for instantaneous measurement and control of process variables...

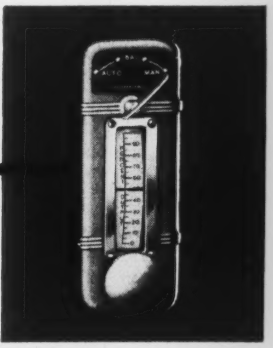

AUTRONIC RECORDER
SWARTWOUT
MANUAL CONTROL
AUTRONIC CONTROL by SWARTWOUT
AUTRONIC CONTROL UNIT (INCORPORATES ADJ. PROP BAND, RESET & RATE)
SECTION OF GRAPHIC PANEL
PRIMARY ELEMENT TRANSMITTER (MEASURES TEMP, PRESS, LIQUID LEVEL, FLOW, ETC.)
18-20 PSI AIR PRESSURE
POWER RELAY
CONTROL VALVE
CONSTANT VOLTAGE TRANSFORMER
115 V 60 ~ AC POWER
POWER LINE

1 Regardless how fast a pneumatic or electro-mechanical system may function, it cannot compare with the *instantaneous, all-electronic* response of the Swartwout Autronic Control System. Here's why. Since transmission of information throughout the system is by *electrical means only,* there is no mechanical motion . . . no slide wires, boosters or motors to initiate control action . . . no control air lines from primary element or to final element. Hence the Autronic Control System *spans distance between primary and final elements without interval* —for closer, more accurate control.

A-4940


RESET
AUTRONIC CONTROL
THE SWARTWOUT CO.
SET POINT





2 **AUTRONIC CONTROLLER,** heart of the system, has no moving parts. Proportion, reset and rate-action adjustments; with or without built-in set-point adjustment. Extremely compact, plug-in type units are interchangeable; can be used direct or reverse-acting.

3 **AUTRONIC RECORDER** operates without slide wires or other contacting mechanisms. Electronically controlled pen gives true linear trace. Unit holds 1-month supply of standard 3-inch linear or square root chart paper. Set-point adjustment optional with Autronic Recorder.

4 **AUTRONIC MANUAL CONTROL** makes bumpless changeovers simple. No gauges to synchronize, no readings to remember because indicator shows *difference* between actual and desired output.

Swartwout *Autronic* CONTROL SYSTEM

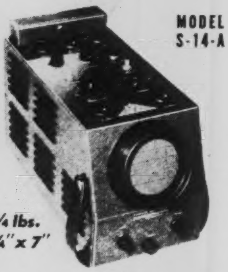
SEND FOR BULLETIN A-701 • THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

THE

HI-GAIN Industrial

POCKETSCOPE

BY WATERMAN



MODEL
S-14-A

Wt. 12 ¾ lbs.
12" x 5¾" x 7"

Another Waterman POCKETSCOPE providing the optimum in oscilloscope flexibility for analyses of low-level electrical impulses. Identified by its hi-sensitivity and incredible portability, S-14-A POCKETSCOPE now permits "on-the-spot" control, calibration and investigation of industrial electronic, medical and communications equipment. Direct coupling without peaking, used in the identical vertical and horizontal amplifiers, eliminates undesirable phase shifting. Designed for the engineer and constructed for rough handling, the HI-GAIN POCKETSCOPE serves as an invaluable precision tool for its owner.

Vertical and horizontal channels: 10mv rms/inch, with response within —2DB from DC to 200KC and pulse rise of 1.8μs. Non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude. Repetitive or trigger time base, with linearization from ½cps to 50KC with ± sync. or trigger. Trace expansion. Filter graph screen. Mu metal shield. And a host of other features.

WATERMAN PRODUCTS CO., INC.
PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

WATERMAN PRODUCTS INCLUDE:

S-4-A SAR PULSESCOPE
S-5-A LAB PULSESCOPE
S-10-B GENERAL POCKETSCOPE
S-11-A INDUSTRIAL POCKETSCOPE
S-14-B WIDE BAND POCKETSCOPE
S-15-A TWIN TUBE POCKETSCOPE

Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC TUBES and other equipment

WATERMAN PRODUCTS

Manufacturers' New Literature

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1627.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

Temperature

U-1062 **Resistance Thermometer.** New 12-page Bulletin 230-C describes and illustrates the "Bailey Pyrotron Recorder" for resistance thermometry. Includes features and typical applications.—Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

U-1063 **Vapor-tension Thermometers.** New 30-page illustrated Catalog 76-T describes maker's expanded line of vapor-tension dial thermometers. Includes principles of operation, complete specifications, standard temperature ranges.—Jas. P. Marsh Corp., Skokie, Ill.

U-1064 **Thermocouple Head.** New 2-page illustrated Bulletin 5601 describes maker's multi-purpose screw-type thermocouple head. Includes features and dimensions.—Minneapolis-Honeywell Regulator Co., Sta. 213, Brown Instruments Div., Phila. 44, Penna.

U-1065 **Temperature Test Chambers.** New 8-page illustrated brochure describes features, standard and optional equipment of maker's freezers and test chambers. Includes specifications of complete line.—Webber Appliance Co., Inc., 2740 Madison Ave. Indianapolis 3, Ind.

U-1066 **Test-chamber Control.** New 4-page Instrumentation Data Sheet 11.0-5a illustrates and describes maker's instrumentation of test chambers made by Tenney Engineering Co. Discusses control problems; gives uses and equipment requirements.—Minneapolis-Honeywell Regulator Co., Sta. 213, Brown Instruments Div., Phila. 44, Penna.

U-1067 **Temperature Bath.** Two new bulletins illustrate and describe maker's constant-temperature bath and refrigerated cloud and pour test apparatus for laboratory use. Includes features and application.—Krebs Elec. & Mfg. Co., Inc., 237 Lafayette St., New York 12, N. Y.

U-1068 **Thermometers.** New 4-page Catalog 16-A illustrates and describes maker's line of thermometers for general utility use.—H-B Instrument Co., 2633 Trenton Ave., Phila. 25, Penna.

U-1069 **Thermometers.** New 4-page Catalog A-52 illustrates and describes over 200 different thermometers from minus 330 to plus 760 deg. F.—Brooklyn Thermometer Co., 217-09 Merrick Blvd., New York, N. Y.

U-1070 **Pyrometer.** New 2-page Bulletin 17 illustrates and describes maker's portable indicating pyrometer and millivoltmeter for laboratory and industrial use.—Thermo Electric Mfg. Co., Dubuque, Iowa.

U-1071 **Thermistor Thermometer.** New 2-page Engineering Form 13-652 illustrates and describes maker's temperature-indicating instrument for from 15 to 120 F. in 6 ranges. Gives applications, specifications, and features.—Beckman & Whitley, Inc., 930 San Carlos Ave., San Carlos, Calif.

U-1072 **Molten-bath Temperature.** New 4-page Data Sheet 6.4-8a covers basic instrumentation requirements for measurement of molten-steel temperatures. Describes "Electronik" recorder with integral balance detector and signalling unit, and description of thermocouple assembly, sample chart record, and specifications for installation.—Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila. 44, Penna.

U-1073 **Strip Heaters.** New 4-page issue 48 of "Chromalox News" illustrates and describes maker's line of 500-watt "Chromalox" strip heaters with article on heating problems.—Edwin L. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Penna.

U-1074 **Temperature Indicator.** New supplementary sheet includes instructions for using "Tempilaq" to determine attained temperature. Special techniques are discussed.—Tempil Corp., 11 W. 25th St., New York 10, N. Y.

Pressure

U-1075 **Pressure Gages.** New 42-page catalog describes and illustrates maker's large line of pressure gages and accessories. Includes condensed chart on specifications, individual specifications, applications, and prices.—J. E. Lonergan Co., 2nd and Race Sts., Phila. 6, Penna.

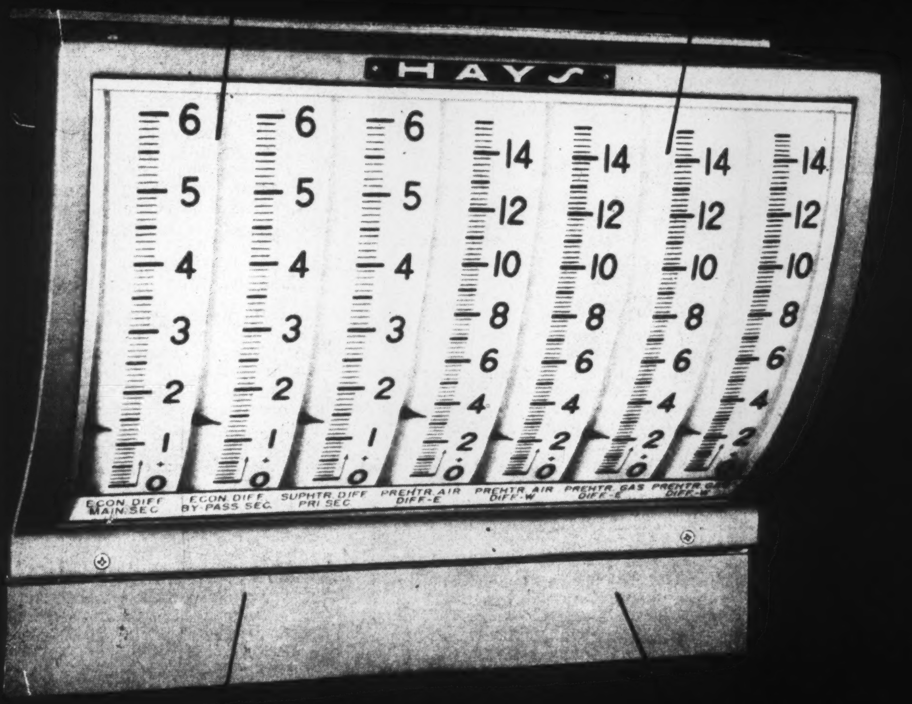
U-1076 **Pressure Regulator and Pump Governor.** 4-page Bulletins Nos. 101, 2, 3, and 6 illustrate and describe maker's pressure regulator and pump governor (steam, air and water); steam and air traps for 600-lb. pressure; automatic boiler feed-water controller; reducing and regulating valves. Includes complete installation instructions.—The C. E. Squire Co., 18502 Syracuse Ave., Cleveland 10, Ohio.

U-1077 **Vacuum Apparatus.** New 6-page Bulletin 12-k illustrates and describes maker's burner torches, gas-air mixers, fishtail burners, blow torches,

a new draft gage!

easy to remove
separate units

easy to read—
no glare, no parallax



easy zero check
from the front

exclusive magnetic access
door—no screws, latches, handles

Available in four mountings

Semi-flush mounting

Eye-level mounting

Recessed mounting

Projected mounting

the HAYS Vertiscale

You designed this draft gage! You asked for these features!
Accessibility from the front makes possible easy "one man" method of quickly checking zero. (The fast 3-way cock with test fitting is *standard* on the Hays Vertiscale).
Simple maintenance—individual units can be quickly removed for inspection or adjustment. Removal does not affect other units in the case, does not disturb calibration of unit being re-installed.
No parallax—design eliminates reflections regardless of viewing angle.
No glare—internal fluorescent lighting is standard.
You get all these values *plus* functional styling in the Hays Vertiscale draft gage!
Write today for full information on the Hays Vertiscale Bulletin 52-1060-210.

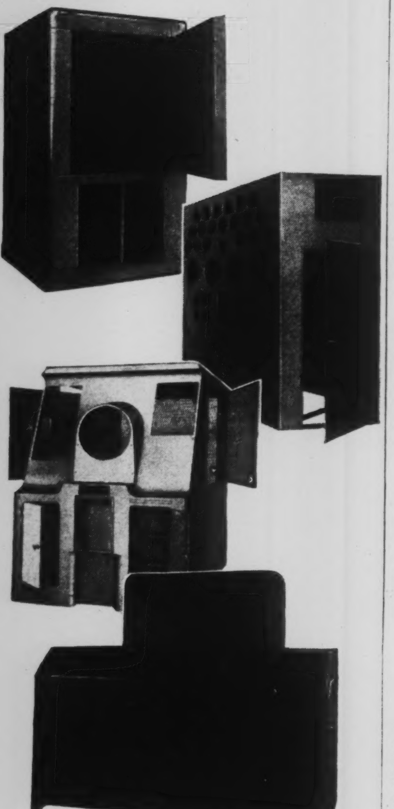
Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO₂ Recorders
Electronic Oxygen Recorders

THE hays CORPORATION

MICHIGAN CITY 8, INDIANA

OUR FIRST GOAL IN FABRICATING INSTRUMENT MOUNTING STRUCTURES

Artisans and engineers at Littleford understand and meet exacting requirements of manufacturers of electrical and hydraulic control equipment. Hence Littleford has become a foremost builder of such cabinets, panels, control boards, steel cubicles, mechanism boxes. Get structures right—get Littleford!



FABRICATORS OF PLATE AND SHEET METALS

LITTLEFORD

LITTLEFORD BROS., INC.
424 E. Pearl St., Cincinnati 2, Ohio

NEW MANUFACTURERS' LITERATURE

compound vacuum pumps, and recording counters for research work. Includes applications, specifications, and prices.—Research Vacuum Supply Co., 3434 Montrose Ave., Chicago 18, Ill.

U-1078 **Pressure Control.** New 20-page booklet describes and illustrates maker's vane-type air-flow switch, pressure air-flow switch, static pressure controls, and other products.—Coral Designs Div., The Henry G. Dietz Co., 12 Astoria Blvd., Long Island 2, N. Y.

U-1079 **Pressure Transducers.** New 2-page illustrated brochure describes maker's "Model-D" pressure transducer for from 0-20 to 200 psi. Includes construction details, principle, and specifications.—Servonic Instruments, 1193 W. Second St., Pamona, Calif.

Flow

U-1080 **Flowmeters.** New 26-page Catalog 2300 describes and illustrates maker's new line of evenly graduated flowmeters. Covers characterized bell for square-root extraction, and electronic integrating mechanism. Includes electric meter utilizing induction-bridge system for remote measurements, "ElectroniK" flow recorder-indicator, and area-type meter for measurement of viscous flows.—Sta. 213, Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila. 44, Penna.

U-1081 **Flow Indicators.** New 12-page bulletin describes and illustrates maker's line of flow indicators that indicate fluid flow and its direction in pipelines by position of a flapper or ball, or by rotation of wheel observed through sight glass. Includes applications, specifications, types, and operation.—Schutte and Koerting Co., Cornwells Heights. Bucks County, Penna.

U-1082 **Photoelectric Flow Monitor.** New 2-page Bulletin 522 describes application of "electric eyes" to process industries—monitoring of process flows and techniques used for gases or liquids. Includes drawings of sample tank and look boxes.—Ess Instrument Co., 96 S. Washington Ave., Bergenfield, N. J.

U-1083 **Open Flow Nozzle.** New 8-page Bulletin 135-J5 illustrates and describes open-flow "Kennison Nozzle" which measures flow of liquids with or without suspended matter. Includes construction, dimensions, installation, capacities, and accuracy data.—Builders-Providence, Inc., Providence, R. I.

Process Control

U-1084 **Pneumatic Controller.** 20-page Catalog C-50 illustrates and describes maker's "P-4 Pneumatrol" pneumatic controller for industrial processes. Includes principles, construction, and accessories.—Fischer & Porter Co., Hatboro, Penna.

U-1085 **Power-plant Control Systems.** New 12-page Bulletin 15-H contains descriptions, diagrams, and photographs of maker's large line of meters and controllers for various types of power plants and industrial processes. Includes operation and applications.—Bailey Meter Co., 1044 Ivanhoe Rd., Cleveland 10, Ohio.

U-1086 **Manual Controller.** New 4-page Bulletin A-705 on "Type M2C Autronic Manual Controls" includes phantom and schematic views, features, operating principles, and performance characteristics of manual control unit for use with maker's electronic control system.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

U-1087 **Liquid-level Controller.** New 12-page illustrated Bulletin 2503 describes maker's float and flexible-shaft type liquid-level controllers. Includes principles, advantages, specifications, and installation details.—Moore Products Co., H & Lycoming, Phila. 24, Pa.

U-1088 **Magnetic Amplifiers.** New 2-page bulletin describes and illustrates maker's magnetic amplifiers. Includes information on features and applications.—Acme Electronics Inc., 300 N. Lake Ave., Pasadena, Calif.

Steam and Combustion

U-1089 **Combustion Safeguard.** New 4-page Bulletin 9603 describes and illustrates maker's multiple-burner "Protectoglo" systems. Includes system components, options available, dimensional and operational data, and combustion safeguard systems.—Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila. 44, Penna.

U-1090 **Steam Specialties.** New 32-page catalog 68F describes and illustrates maker's steam traps, strainers, regulating and reducing valves, separators, and vacuum and lifting traps. Includes applications, dimensions, and prices. Also steam table.—Strong, Carlisle & Hammond Co., 1392 W. Third St., Cleveland 13, Ohio.

U-1091 **Water Conditioning.** 4-page illustrated bulletin gives features and specifications of "Uniflow" equipment for water softening, filtration, and iron removal. Includes capacities and analysis service.—Uniflow Mfg. Co., Erie, Penna.

Computers

U-1092 **Electronic Computer.** New 24-page illustrated brochure describes maker's "REAC" office-size electronic computer and its various applications. Includes comprehensive explanation on theory of operation with diagrammed examples and units.—Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y.

U-1093 **Computer Amplifier.** New 3-page brochure illustrates and describes maker's utilized operational amplifier for d-c. analog systems, fast and slow. Includes specifications and suggested applications.—George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

U-1094 **Digital Graph Plotter.** New 4-page bulletin describes and illustrates maker's new "Logrinc" digital graph plotter. Includes features, specifications, basic components, and applications.—

Logistics Research Co. 141 South Pacific Ave., Redondo Beach, Calif.

Servomechanisms

U-1095 **Servomechanisms.** New 20-page booklet MDA 200 describes and illustrates maker's foundation boards, mounting blocks, bearing blocks, shafts, gears, couplings, and other servomechanism components, including specifications.—Servomechanisms Inc., Post and Stewart Ave., Westbury, N. Y.

Testing and Inspection

U-1096 **Dynamometers.** New 2-page illustrated Form 882 describes maker's dynamometers, thermometers, universal testers, and mechanical pressure gages for industrial use.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

U-1097 **Vibration Testing.** New 24-page illustrated Bulletin 1-VE describes maker's extensive line of vibration exciters and calibrators. Includes principles, applications, specifications, and accessories.—The M B Mfg. Co., Inc., 1060 State St., New Haven 11, Conn.

U-1098 **Spring Tester.** New 4-page brochure ilustrates and describes maker's spring testers and coilers for compression and extension springs. Includes operation, construction, accuracy, accessories, and capacity listings.—The Carlson Co., 277 Broadway, New York 7, N. Y.

U-1099 **Surface Roughness.** New 4-page illustrated Bulletin L21 "How to Specify Surface Roughness—and Why" describes surface roughness specifications. Tells where and how to apply specifications.—Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

U-1100 **Strain and Temperature Recorder.** New 8-page brochure describes and illustrates maker's dynamic temperature and strain recorder "Model 204." Includes features, uses, components and performance specifications.—Allegheny Instruments Co., Inc., 1000 Oldtown Rd., Cumberland, Md.

U-1101 **Magnetic Flaw Detectors.** New 4-page brochure illustrates and describes operation and advantages of maker's "Probotester" and "Proboscope" for testing iron and steel parts for flaws.—Magnetic Analysis Corp., 42 Twelfth St., Long Island City 1, N. Y.

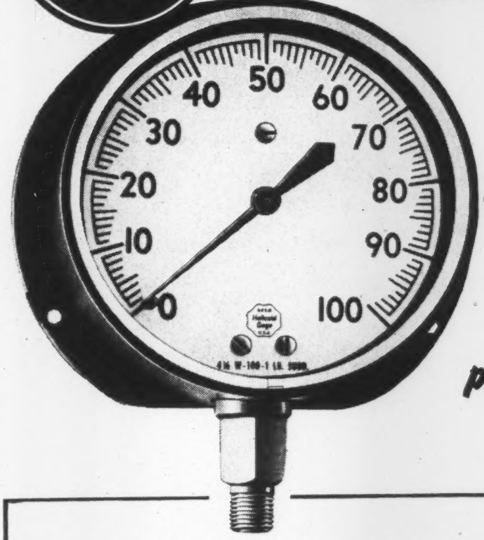
U-1102 **Testing Machine.** New 4-page Bulletin 4202 illustrates and describes "Baldwin-Emery SR-4" testing machine of 50,000-lb. capacity. Explains operation, specifications, and auxiliary devices.—Baldwin-Lima-Hamilton Corp., Phila. 42, Penna.

U-1103 **Magnetic Analysis Equipment.** New 32-page bulletin describes and illustrates maker's magnetic inspection equipment. Gives samples of flaws found only by magnetic inspection. Includes applications, advantages, and methods. Lists users.—Magnetic Analysis Corp., 42 12th St., Long Island City 1, N. Y.

U-1104 **Metals Tester and Crystal Diode.** Bulletins B-46A and B-44 describe maker's germanium crystal diode "GCD-1," and magnetic metals tester

an ACCO product

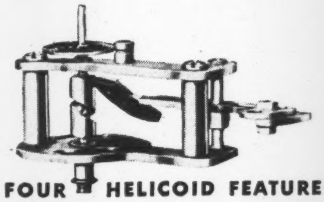
HELICOID



The gage that retains its original accuracy longer, lasts longer, costs less per gage, per year

● Only HELICOID GAGES have the Helicoid Movement . . . tested and proved in years of hard service . . . a simple cam and roller design that does not have any teeth to wear out. Helicoid Gages cost less in the long run because they give long, trouble-free service with a minimum of maintenance.

Helicoid Gages can be furnished with ACALOY cases in flanged (illustrated), flangeless or flush mounting (round or square); also in phenol—with black, white or phosphorescent dials; phosphor bronze, alloy steel, stainless steel or K Monel Bourdon tubes; in pressure, vacuum or compound types; in a full range of pressures; all with the Helicoid stainless movement.



FOUR HELICOID FEATURES

Write today
for the Helicoid Catalog

1. Stainless Steel Helicoid Roller (no gear teeth)
2. Stainless Steel Hair Spring
3. Long Life Cam (no gear teeth)
4. Corrosion Resistant Link and Screws

ACCO

HELICOID Pressure • Vacuum GAGES

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE
929 Connecticut Avenue • Bridgeport 2, Connecticut

Automatic

"STRAIGHT-LINE"

TEMPERATURE CONTROL

with

XACTLINE

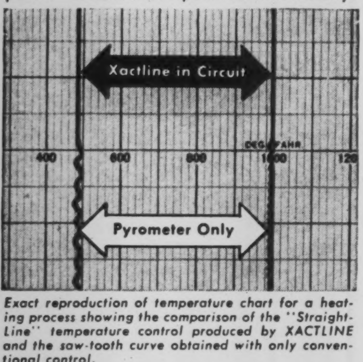
ELIMINATE

Overshooting

Undershooting

Are you going to continue to put up with that troublesome overshooting and undershooting inherent in your conventional pyrometer control—especially when it is so easy to eliminate that saw-tooth effect?

Put XACTLINE in the control circuit. XACTLINE anticipates the temperature changes—before they occur. And too, it nullifies the varying amounts of thermal lag, residual heat, and mechanical lag—producing a short on-off cycle resulting in "Straight-Line" temperature control. This performance is possible because there is no dependence upon mechanical parts—XACTLINE operates electrically.



Exact reproduction of temperature chart for a heating process showing the comparison of the "Straight-Line" temperature control produced by XACTLINE and the saw-tooth curve obtained with only conventional control.

XACTLINE is applicable to any indicating or recording pyrometer control of the millivoltmeter or potentiometer type. It should be used wherever close temperature control is required—any type of electrically heated oven, furnace, kiln, injection molding machine, and fuel-fired furnaces equipped with motor-operated or solenoid valves.

XACTLINE is a complete unit. No adjustment or coordination with the control instrument is required regardless of the size of the furnace, length of the heating cycle, or size of the load. Installation is very simple—can be either flush or surface mounted.

PRICE **$89.50** F.O.B. CHICAGO
Nothing else to Buy

GORDON SERVICE

CLAUD S. GORDON CO.
Manufacturers & Distributors
Thermocouple Supplies • Industrial Furnaces & Ovens
Pyrometers & Controls • Metallurgical Testing Machines
Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

"Model 44." Includes construction, features, and specifications.—Berkshire Laboratories, Lincoln, Mass.

Optical

U-1105 **Measuring Microscopes.** New 26-page illustrated Bulletin 161-48 describes maker's measuring microscopes. Includes optic principles, selection and use, and construction of maker's microscopes. Also types and applications.—The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

U-1106 **Microscope.** New 8-page Bulletin 147-50 describes and illustrates maker's toolmakers' microscope. Includes features, general description, accessories, prices, and condensed specifications.—The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

U-1107 **Microscope.** New 2-page Bulletin 183-50 describes and illustrates maker's spotting attachment for maker's toolmaker's microscope. Includes information as to applications and operation.—The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

U-1108 **ITV Camera.** New 2-page bulletin describes and illustrates maker's portable industrial television camera. Includes applications and dimensions.—Dage Electronics Corp., 69 N. 2nd St., Beech Grove, Ind.

Laboratory Apparatus

U-1109 **Laboratory Apparatus.** New 20-page No. 52-10-48 issue of the "Announcer" illustrates and describes Zahn viscosimeters, variable transformers, temperature recorder, refractometers, and mercury purification apparatus. Includes article on mercury purification.—Eberbach & Son Co., Ann Arbor, Mich.

U-1110 **Laboratory Apparatus.** 40-page Vol. 22 No. issue of "The Laboratory" describes B & L refractometer and other instruments for laboratory use—unitized bath system, tester for combustible material, clinical electrophotometer for medical diagnoses and new semi-micro centrifuge.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

U-1111 **Laboratory Apparatus.** New 8-page issue Vol. 4, No. 2 of "Lanco Apparatus News" describes "Con-Wate" mechanical convection oven, thermoregulators, refractometers and other laboratory apparatus.—Arthur S. La Pine & Co., 6001 S. Knox Ave., Chicago 29, Ill.

U-1112 **Laboratory Apparatus.** New 4-page general index to Gaertner literature gives alphabetical list of bulletins and booklets available on Gaertner products. Includes bulletins in print or in preparation.—The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

U-1113 **Balance.** New 8-page booklet describes direct-reading, single-pan "Gram-atic" balance, which eliminates all handling of weights, gives readings in 20 seconds. Outlines weighing procedure, lists balance specifications.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

U-1114 **Photoelasticity Demonstrator.** New 2-page bulletin illustrates and describes maker's "P-4" polaroid photoelastic demonstration apparatus. Includes plastic specimens.—Ann Arbor Instrument Works, Ann Arbor, Mich.

Chemical Process Analysis

U-1115 **pH.** New 4-page Data Sheet 10.7-1 describes and illustrates maker's system for automatic recording and control of pH. Includes discussion of measuring system components, adjustments for operation, and systems for electric or pneumatic modes of control.—Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Phila. 44, Penna.

U-1116 **X-ray Analysis.** New 8-page illustrated booklet describes maker's 3 X-ray techniques for nondestructive analysis. Includes principles of operations, and field of application with expected results.—North American Philips Co., Inc., 750 So. Fulton Ave., Mt. Vernon, N. Y.

U-1117 **Mass Spectrometer.** New 2-page Bulletin MS 1 illustrates and describes maker's mass spectrometer "Model M 60" for analysis of isotopic and complex gas mixtures.—Process & Instruments, 60 Greenpoint Ave., Brooklyn 22, N. Y.

U-1118 **Conductometer.** New 8-page edition No. 9 of "The Beckman Bulletin" details the theory and design of maker's high-frequency conductometer for detecting end points in titration reactions, plus other illustrated articles on new instruments and accessories.—Beckman Instruments, Inc., S. Pasadena 3, Calif.

U-1119 **Electroconvection Apparatus.** New 2-page bulletin describes and illustrates maker's "Raymond" electroconvection apparatus for fractionation of colloid mixtures by electrophoretic technique. Includes features and applications.—E-C Apparatus Co., 23 Haven Ave., New York 32, N. Y.

U-1120 **Centrifugal Contactors.** 20-page illustrated Brochure 10 contains "album" of installations of maker's centrifugal multi-stage counter-current contactors. Includes principles, features, models, and many installation pictures.—Podbielniak, Inc., 341 E. Ohio St., Chicago 11, Ill.

U-1121 **Viscometer.** New data sheet describes operation and features of maker's temperature compensator and multiprobe system for ultrasonic viscometer.—The Ultra-Viscoson Corp., 1240 Main St., Hartford, Conn.

U-1122 **Gas Liquefiers.** New 24-page illustrated brochure describes maker's liquefiers for helium, hydrogen, and oxygen. Also other equipment for producing, handling, and storing liquefied gases.—Arthur D. Little, Inc., 30 Memorial Dr., Cambridge 42, Mass.

Radioactivity

U-1123 **Nuclear Instruments.** New 12-page catalog and price list gives maker's line of nuclear instruments, accessories and services. Includes scalers, counters, detectors.—Nucleonic Co. of America, 497 Union St., Brooklyn 31, N. Y.

Valves

U-1124 **Safety and Relief Valves.** New 86-page Bulletin 800 V completely illustrates and describes maker's extensive line of safety and relief valves for boilers, hydraulic systems, etc. Includes construction, new features, prices, and specifications.—J. E. Lonergan Co., 2nd and Race, Phila. 6, Penna.

U-1125 **Steam-pressure Regulating Valves.** New 12-page bulletin 535 describes and illustrates maker's line of steam-pressure regulating valves, and introduces three new items. Complete sizing tables are included and a section on "Choosing A Regulating Valve." —D'Este Div., Kaye & Mac Donald, Inc., 11 Central Ave., West Orange, N. J.

U-1126 **Gate Valve.** New 4-page Bulletin 535 illustrates and describes features and specifications of maker's new 75-psi. gate valve with aluminum body.—The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

U-1127 **Relief Valves.** New 2-page Bulletin L-108 describes and illustrates maker's combination temperature and pressure relief valves for hot water tanks and heaters. Include pressure relief capacities chart.—McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.

U-1128 **Solenoid-operated Valves.** New 4-page bulletin describes and illustrates maker's solenoid-operated valves. Includes operation, types, applications, and dimensions.—Atkomatic Valve Co. 545 West Abbott St., Indianapolis, Ind.

Tubing and Fittings

U-1129 **Aluminum Fittings.** New 4-page Bulletin 4316 B2 illustrates and describes maker's line of "Triple Lok" fittings. Includes hydraulic and fluid handling applications where aluminum tubed systems can be used.—The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

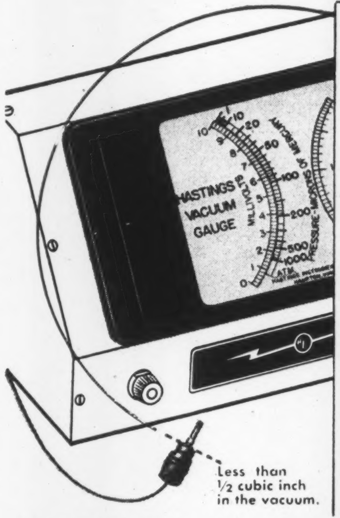
U-1130 **Flexible Tubing.** New 16-page illustrated catalog CC-400 describes maker's flexible metal hose and tubing made in two basic types: seamless and strip wound. Shows wide range of available alloys and sizes, applications, and fittings.—The American Brass Co., American Metal Hose Branch, Waterbury 20, Conn.

U-1131 **Tubing Support.** New 4-page Bulletin 65-1 illustrates and describes new "COPE INSTROF," a standard system for supporting instrument tubing, which eliminates engineering, field fabrication, and clamp installations. Includes sizes and styles.—T. J. Cope, Inc., 711 S. 50 St., Phila. 43, Penna.

U-1132 **Wire Markers.** New 8-page Bulletin 551 illustrates and describes maker's "E-Z Code Markers" for use on wire, pipe, cable, etc.—Western Lithograph Co., 600 E. Second St., Los Angeles 54, Calif.

Contamination, Corrosion and Outgassing Free!

VACUUM MEASUREMENT IN THE MICRON RANGE



Less than ½ cubic inch in the vacuum.

The Hastings Vacuum Gauge gives continuous direct readings in microns of mercury — *without* range switching or calibration factors. Only one control knob is needed for initial setting. After that, the calibration holds indefinitely, regardless of pressure changes.

The stability and wide range of this gauge (1 to 1000 microns) makes it extremely suitable for both laboratory and production use in vacuum tube manufacture, distillation, automatic exhaust machines, dehydration and refrigerator servicing. Its rapid response to pressure changes makes it especially suitable for leak detection, warning devices and pressure operated controls.

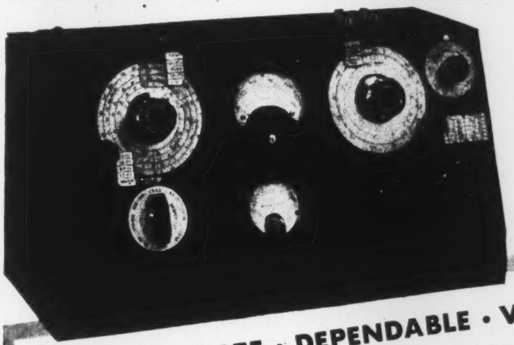
Hasting's exclusive noble metal thermocouple design gives accuracy, long life and a low operating temperature. This construction prevents fluctuations due to ambient temperature changes and reduces the time constant to less than 1/2 second.

Write today for free literature and prices. Other Hastings ultra sensitive precision instruments include electronic flowmeters, manometers, air velocity meters and electronic standard cells.

HASTINGS INSTRUMENT COMPANY, INC.

HAMPTON, 35, VIRGINIA

DESIGNERS AND BUILDERS OF RAYDIST AND SPECIAL ELECTRONIC, ELECTRICAL, AND MECHANICAL INSTRUMENTS



The **Q METER**

TYPE 160-A

ACCURATE • DEPENDABLE • VERSATILE

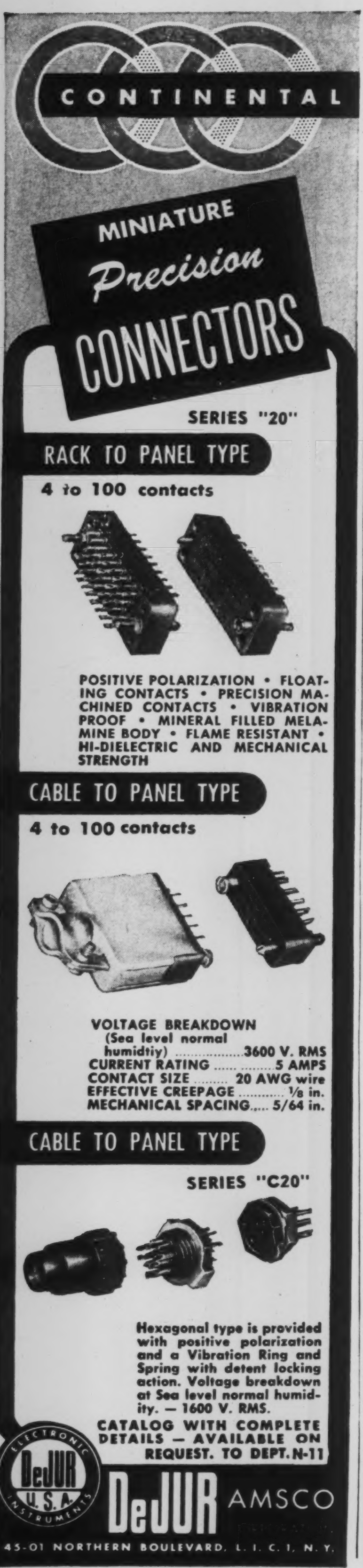
For the measurement of Q, inductance, and capacitance, the 160-A Q-Meter is the universal choice of radio and electronics engineers. Its wide frequency coverage from 50 kc. to 75 mc. is an outstanding feature which makes possible the accurate and rapid evaluation of components and insulating materials at the *actual* operating frequency.

SPECIFICATIONS

OSCILLATOR FREQUENCY RANGE: 50 kc. to 75 mc. 8 self contained ranges.
OSCILLATOR FREQUENCY ACCURACY: ± 1%, 50 kc.-50 mc. ± 3%, 50 mc.-75 mc.
Q-MEASUREMENT RANGE: Directly calibrated in Q, 20-250. "Multiply-Q-By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q-range to 625.
Q-MEASUREMENT ACCURACY: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.
CAPACITANCE CALIBRATION RANGE: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf. whichever is greater. Vernier capacitor section +3 mmf., zero, -3 mmf. calibrated in 0.1 mmf. steps. Accuracy ± 0.1 mmf.

Write for literature containing further details

BOONTON RADIO *Corporation*
BOONTON N J U S A
BRC



CONTINENTAL

MINIATURE
Precision
CONNECTORS

SERIES "20"

RACK TO PANEL TYPE

4 to 100 contacts

POSITIVE POLARIZATION • FLOATING CONTACTS • PRECISION MACHINED CONTACTS • VIBRATION PROOF • MINERAL FILLED MELAMINE BODY • FLAME RESISTANT • HI-DIELECTRIC AND MECHANICAL STRENGTH

CABLE TO PANEL TYPE

4 to 100 contacts

VOLTAGE BREAKDOWN (Sea level normal humidtiy) .... 3600 V. RMS
CURRENT RATING .... 5 AMPS
CONTACT SIZE .... 20 AWG wire
EFFECTIVE CREEPAGE .... 1/8 in.
MECHANICAL SPACING..... 5/64 in.

CABLE TO PANEL TYPE

SERIES "C20"

Hexagonal type is provided with positive polarization and a Vibration Ring and Spring with detent locking action. Voltage breakdown at Sea level normal humidity. — 1600 V. RMS.

CATALOG WITH COMPLETE DETAILS — AVAILABLE ON REQUEST. TO DEPT. N-11

ELECTRONIC DeJUR U.S.A. INSTRUMENTS

DeJUR AMSCO

45-01 NORTHERN BOULEVARD, L. I. C. 1, N. Y.

NEW MANUFACTURERS' LITERATURE

Recording

U-1133 **Multi-channel Recording.** New 12-page issue Vol. 6 No. 3 of "CEC Recordings" contains 8 illustrated articles on maker's line of test and multichannel recording equipment. Includes construction data, features, and varied applications.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

U-1134 **Electronic Recorders.** New 8-page issue Vol. 12 No. 2 of "Modern Precision" describes maker's "Speedomax" X-Y recorder for industrial use. Includes other articles on control instruments employed by process industries.—Leeds & Northrup Co., 4907 Stenton Ave., Phila. 44, Penna.

U-1135 **Recording Oscillographs.** New 8-page September issue of "Brush Strokes" illustrates and describes maker's recording oscillographs and amplifiers used to record operation of resistance-welding machines.—The Brush Development Co., 3322 Perkins Ave., Cleveland, Ohio.

U-1136 **Recorders.** New 16-page Bulletin 23M describes and illustrates features of maker's direct-writing recorders. Lists users and representatives.—Sanborn Co., Industrial Div., Cambridge 39, Mass.

U-1137 **Multi-channel Recording.** New 12-page Vol. 2 No. 3 issue of "Hathaway Engineering News" includes articles on high-voltage oscillograph, strain measurement, and transient measurements.—Hathaway Instrument Co., 1315 So. Clarkson, Denver, Colo.

Timers

U-1138 **Automatic Timers.** New 2-page Bulletin Z-52, 652, 452 illustrate and describe maker's automatic timers for industrial and general use. Gives features, applications, and principles of operation.—The Tork Clock Co., Inc., Mt. Vernon, N. Y.

Microwave Equipment

U-1139 **Microwave Equipment.** New 134-page illustrated catalog describes maker's complete line of adapters, oscillator units, detector holders, antennas, tees, waveguide switches, etc. Opening 36 pages are devoted to microwave principles. Section of 21 pages on uses of microwave test equipment and calibration procedures.—De Mornay-Bonardi, Inc., Los Angeles, Calif.

U-1140 **Microwave Instruments.** New 4-page illustrated brochure describes maker's "Microwave Mega-Nodes" for noise-figure measurements; "Centilator" signal sources; "Microwave Mega-Match" for X-band impedance-match indicator. Give specifications.—Kay Electric Co., 25 Maple Ave., Pine Brook, N. J.

U-1141 **Microwave Assemblies.** New 6-page folder describes and illustrates maker's microwave components and ability to fabricate precision assemblies according to manufacturers' needs. Includes history of service.—N.R.K. Mfg. & Engineering Co., 5644 N. Western Ave., Chicago 45, Ill.

Resistance and Continuity

U-1142 **Resistance Meter.** New 4-page brochure illustrates and describes new Model C-3 resistance meter for leakage and continuity. Includes circuit description, construction, and specifications.—Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Rd., Houston 19, Texas.

U-1143 **Continuity and Leakage Tester.** New 2-page brochure illustrates and describes maker's "Auditone" continuity and leakage tester which checks circuits from zero to 100 megohms.—Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.

U-1144 **Filament and Continuity Checker.** New 2-page bulletin describes and illustrates maker's filament and continuity checker "Model FC-1." Includes features, price, and operation.—Pomona Electronics Co., Pomona, Calif.

U-1145 **Insulation Tester.** New 4-page Bulletin 461 describes and illustrates new "Model P-1" plug-in-type "Megohmeter" insulation tester. Includes information on power supply, plug-in socket, and specifications.—Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y.

U-1146 **Soil-resistivity Apparatus.** Illustrated brochures describe maker's soil rods, electrodes, and galvanometers for measuring electrical resistivity of soils, waters, emulsions, etc. Includes construction and operation.—J. L. Collins, Angleton, Texas.

U-1147 **High-Potential Test Set.** New 4-page illustrated brochure describes operation, advantages, and safety features of maker's d-c. high-potential test and cable fault-locating set for use on power cable systems.—Peschel Electronics, Inc., 13 Garden St., New Rochelle, N. Y.

Communication and Telemetering

U-1148 **Amplifiers and Communication Equipment.** New 16-page Catalog 16 illustrates and describes maker's extensive line of amplifiers, tape and disk recording apparatus, sound systems, and film recording equipment. Gives specifications; circuit layout, accessories.—Cinema Engineering Co., 1510 W. Verdugo Ave., Burbank, Calif.

U-1149 **Telemetering Equipment.** New 4-page brochure presents illustrated descriptions of maker's airborne and ground station equipment and accessories for radio telemetering. Includes features and applications.—Applied Science Corp. of Princeton, P. O. Box 44, Princeton, N. J.

U-1150 **Voice Communication.** New 4-page illustrated Bulletin 26 presents maker's "Audiophone" systems for mines and industrial plants. Includes advantages, typical applications, wiring diagram, and component parts.—Farmers Engineering and Mfg. Co., Irwin, Penna,

Amplifiers

U-1151 **Electrometer.** New 4-page illustrated Instrumentation Data Sheet 10.04-a describes "Brown Electrometer" for minute current measurements. Includes operation, application, stability, and reliability.—Minneapolis-Honeywell Regulator Co., Sta. 213, Brown Instruments Div., Phila. 44, Penna.

U-1152 **Miniature Amplifier-bridge.** New 4-page Folder AD-312 illustrates and describes maker's lightweight miniature amplifier-bridge for capacity-type fuel-gage system. Includes circuit, features, and construction.—Simmonds Aerocessories, Inc., 105 White Plains Rd., Tarrytown, N. Y.

Signal Generators

U-1153 **Oscillator.** New 4-page bulletin describes and illustrates maker's "Model MB-1" low-distortion battery-operated oscillator. Includes schematic circuit diagram, circuit description, and specifications.—Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Rd., Houston 19, Texas.

U-1154 **Audio Signal Generators.** New 4-page Vol. 3 No. 12 issue of the "Hewlett-Packard Journal" illustrates and describes maker's audio signal generators. Completely details principles of operation and basic circuit arrangements.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Oscilloscopes

U-1155 **Oscillograph.** New 4-page bulletin describes and illustrates maker's portable oscillograph "Model 1039." Includes power rating, dimensions, and descriptions of amplifier and cathode-ray tube.—Beam Instruments Corp., Empire State Bldg., 350 Fifth Ave., New York 1, N. Y.

U-1156 **Cathode-ray Oscillograph.** New 12-page Bulletin A-04-A illustrates and describes maker's "Type 304-A" cathode-ray oscillograph. Includes principles, operation, calibration, and specifications.—Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J.

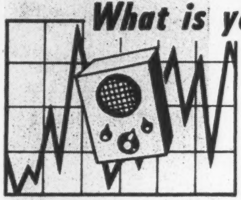
Bridges

U-1157 **Vacuum-tube Bridge.** New 8-page issue Vol. 27 No. 4 of "The General Radio Experimenter" contains technical article on maker's vacuum-tube bridge and accessories. Includes specifications and principles.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

Power Supplies

U-1158 **Regulated Power Supplies.** New 2-page bulletin describes and illustrates maker's regulated d-c. power supply "Model S-715." Includes size, weight, input, and output specifications.—Acme Electronics, Inc., 300 North Lake Ave., Pasadena 4, Calif.

U-1159 **Voltage Regulators.** New 8-page Vol. 5 No. 4 issue of "Currently" contains article on "Characteristics of AC Regulators Using Power Factor Loads." Also described are maker's



What is your Delay or Regulating Problem?

For the most effective solution use the

SIMPLEST, MOST COMPACT
MOST ECONOMICAL
HERMETICALLY SEALED

AMPERITE

***THERMOSTATIC DELAY* RELAYS**

AMPERITE
DELAY
RELAY

STANDARD

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- Circuits: *SPST only*—normally open or normally closed.

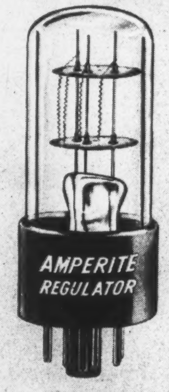
Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and—*very inexpensive!*

MINIATURE

TYPES: Standard Radio Octal, and 9-Pin Miniature.

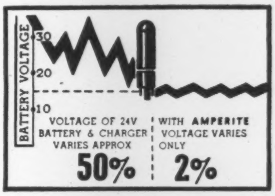
PROBLEM? Send for Bulletin No. TR-81

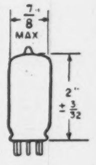
BALLAST-REGULATORS



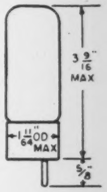
T9 BULB

- **A**mperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
- For currents of 60 ma. to 5 amps. Operates *on A.C., D.C., or Pulsating Current.*
- Hermetically sealed, light, compact, and most inexpensive.





T6½L



T9

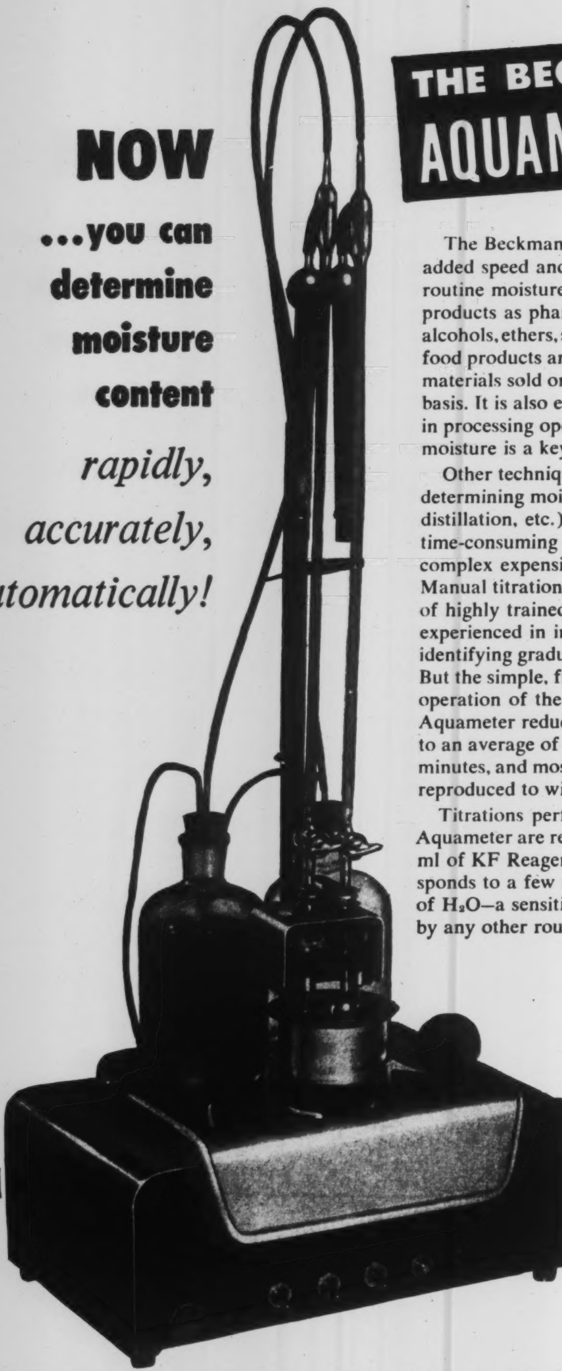
Maximum Wattage Dissipation: T6½L—5W. T9—10W.

Amperite Regulators are the simplest, most effective method for obtaining ***automatic regulation*** of current or voltage. ***Hermetically sealed,*** they are not affected by changes in altitude, ambient temperature (−55° to +90°C), or humidity. Rugged; no moving parts; changed as easily as a radio tube.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO., Inc. 561 Broadway, New York 12, N. Y.

In Canada: Atlas Radio Corp., Ltd., 560 King St., W., Toronto 2B



THE BECKMAN
AQUAMETER

NOW
...you can
determine
moisture
content
rapidly,
accurately,
automatically!

The Beckman Aquameter brings added speed and accuracy to routine moisture analyses of such products as pharmaceuticals, alcohols, ethers, solvents, antibiotics, food products and a host of other materials sold on a moisture-free basis. It is also extensively used in processing operations where moisture is a key indication.

Other techniques now used for determining moisture (oven-drying, distillation, etc.) are tediously time-consuming and necessitate complex expensive equipment. Manual titrations require the skill of highly trained technicians experienced in interpreting and identifying gradual color variations. But the simple, fully automatic operation of the Beckman Aquameter reduces titration time to an average of only one or two minutes, and most titrations can be reproduced to within ±0.05 ml.

Titrations performed on the Aquameter are reproducible to 0.05 ml of KF Reagent, which corresponds to a few tenths milligram of H_2O—a sensitivity unsurpassed by any other routine method.

The Beckman Aquameter applies a new principle to the "dead stop" technique, recognized as the most sensitive of the instrumental methods for Karl Fischer titrations, and recommended by the U. S. Pharmacopoeia. Initial adjustment is simple and easily made, and any number of sequential titrations can be carried out with no further checking or setting, simply by adding the sample and pushing a button. The titration is completed automatically and without attention.

For full details write for Data File #41-47

BECKMAN INSTRUMENTS
control modern industries

BECKMAN INSTRUMENTS, INC.
SOUTH PASADENA, CALIFORNIA
Factory Service Branches: New York—Chicago—Los Angeles

BECKMAN INSTRUMENTS include: pH Meters and Electrodes • Spectrophotometers • Radioactivity Meters • Special Instruments

NEW LITERATURE

"Nobatron-Ranger Models SR-2" and "B-Nobatron" B supplies.—Sorensen & Co., 375 Fairfield Ave., Stamford 12, Conn.

U-1160 **Voltage Stabilizers.** New 12-page illustrated Bulletin GEA-5754 describes maker's automatic magnetic-capacitive voltage stabilizers for from 15 to 5000 volt-amperes. Includes operation, principle, construction, and specifications.—General Electric, Schenectady 5, N. Y.

U-1161 **Dynamotors.** New 8-page bulletin describes and illustrates maker's specialized dynamotors. Includes information on construction, operation characteristics, design factors, and dimensions.—Red Bank Div., Bendix Aviation Corp., Red Bank, N. J.

U-1162 **Inverter.** New 2-page bulletin describes maker's "Type 32E03-1" inverter that changes 26 to 29 volts d.c. to 115 volts a.c. Includes description, specification, and design features.—Red Bank Div., Bendix Aviation Corp., Eatontown, N. J.

U-1163 **Regulated Power Supply.** New 2-page bulletin describes and illustrates maker's voltage regulator "Model 141" with high-voltage B supply and filament supply. Includes specifications.—Kepko Laboratories, Inc., 131 Stanford Ave., Flushing 55, N. Y.

U-1164 **Power Supplies.** New 4-page Catalog EA10512M gives d-c. voltage, current, ripple, regulation, and approximate price of maker's power supplies for voltages from 0-300 to over 300,000 volts. Also described are maker's equipment and projection oscilloscope.—Beta Electric Corp., 333 E. 103 St., New York 29, N. Y.

U-1165 **Inverter.** New 2-page bulletin 98-11C describes and illustrates maker's inverter that changes a d-c. input of 26 to 29 volts to an a-c. output of 115 volts. Includes specifications and design features.—Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

Motors

U-1166 **Fractional-hp. Motors.** New 4-page issue Vol. 32 No. 5 of "The Bodine Motorgram" features articles on (1) use of maker's reducer motor with telephone transmitters and (2) temperature rise measurements in motors.—Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

U-1167 **Motors.** New 30-page catalog describes and illustrates maker's fractional-hp. electric motors. Includes applications, specifications, features, ordering data, types, outline drawings, and performance curve charts.—John Oster Mfg. Co., 1 Main St., Racine, Wis.

U-1168 **Motor Controller.** New 2-page bulletin describes and illustrates maker's "C-25" motor controller for fractional-hp. d-c. motors. Includes operating information, applications, features, and price.—Gerald K. Heller Co., 1540 Ridgely St., Baltimore 30, Md.

Electrical and Electronic Components

U-1169 **Electronic Components.** New 34-page Catalog 28 illustrates and describes maker's large line of components for industry and servicing, including switches, capacitors, controls, printed circuits, and steatite insulators.—Centralab, Div. of Globe-Union, 900 E. Keefe Ave., Milwaukee 1, Wis.

U-1170 **Electronic Components, Test Instruments.** New 210-page Catalog 53 illustrates and describes thousands of electronic components, test instruments, etc., handled by large distributor.—Radio Shack Corp., 167 Washington St., Boston 8, Mass.

U-1171 **Electronic Components.** New 32-page Catalog 28 covers maker's 5 product divisions: variable resistors, ceramic capacitors, rotary and lever switches, printed electronic circuits, and steatite insulators. Fully illustrated and indexed.—Globe Union, Inc., Centralab Div., 900 E. Keefe Ave., Milwaukee 1, Wis.

U-1172 **Electronic Products.** New 16-page brochure illustrates and describes four divisions of maker's electronic products: receiving tube, power tube, equipment, and television and radio. Includes history of company and research activities.—Raytheon Mfg. Co., Waltham 54, Mass.

U-1173 **Resistors.** July-August issue of "The Ohmite News" illustrates and describes maker's new "Powr-Rib" resistor for high-current applications. Other articles on switches, rheostats, etc.—Ohmite Mfg. Co., 4835 Flournoy St., Chicago 44, Ill.

U-1174 **Rheostats.** New 4-page Bulletin 1110 illustrates and describes maker's "Vitrohm" ring-type rheostats. Includes applications, construction details, ratings, dimensions, and accessories.—Ward Leonard Electric Co., Mt. Vernon, N. Y.

U-1175 **Capacitors.** New 20-page Vol. 17 No. 9 issue of "The C-D Capacitor" describes maker's capacitors and his article on use of field-strength meters.—Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

U-1176 **Transformers.** New 10-page illustrated brochure lists and describes maker's line of transformers—output, interstage, filter, reactors, etc. New price list included.—Kenyon Transformer Co., Inc., 840 Barry St., New York 59, N. Y.

U-1177 **Selenium Diodes.** New 4-page Bulletin SD-1 describes and illustrates maker's selenium diodes. Includes specifications, dimensions, color coding, static characteristics, and capacitance per cell.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

U-1178 **Multiplier Phototube.** New 8-page data brochure illustrates and describes maker's high-vacuum multiplier phototube for use in scintillation counters. Includes 6 characteristic curves and typical circuits.—RCA Tube Dept., Harrison, N. J.

U-1179 **Special-purpose Electron Tubes.** New 4-page Bulletin 512-7A describes and illustrates maker's tech-

★ POWER RELAYS
★ SMALL RELAYS
★ SENSITIVE RELAYS
★ LATCH RELAYS
★ INSTRUMENT-CONTROLLED RELAYS and SETS
★ SEQUENCE RELAYS
★ TIMING UNITS
★ SPECIAL-PURPOSE RELAYS

5,348
RELAY TYPES

...mean that you get exactly the right relay for the job!

STRUTHERS -DUNN

Struthers-Dunn, Inc., 150 N. 13th St., Philadelphia 7, Pa.

BALTIMORE • BOSTON • BUFFALO • CHARLOTTE • CHICAGO • CINCINNATI
CLEVELAND • DALLAS • DETROIT • KANSAS CITY • LOS ANGELES
MINNEAPOLIS • MONTREAL • NEW ORLEANS • NEW YORK • PITTSBURGH
ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

SORENSEN

REGULATES AND CONTROLS *electronically*

FREQUENCY

HIGH VOLTAGE DC LOW CURRENT

AC LINE

LOW VOLTAGE DC HIGH CURRENT

Nobatron Model E-6-5

The NOBATRON* maintains stabilized DC voltage under changing line and/or load conditions.

A complete line of catalog models are available, with output voltages of 6, 12, 28, 125, and 200 VDC, from 5 to 350 amperes.

Sorensen Nobatrons eliminate battery and generator troubles. They combine high regulation accuracy with maximum dependability and minimum maintenance.

All models are attractively finished. Most can be furnished either for relay rack mounting or in cabinets for bench-top use. Most units are metered; all are adequately protected against overload by suitable fuses and breakers.

WIDER OUTPUT VOLTAGE RANGE MODELS

Nobatron-RANGERS* are designed to meet the demand for power supplies similar to the Nobatron but with wider output voltage ranges.

Nobatron-RANGERS are continuously adjustable over extended output ranges, yet provide regulation accuracies of ±0.25% against line and/or load. Other specifications are identical to those of the standard Nobatrons.

Three models are available, the SR-30, SR100, SR-2. Capacities, respectively, are 3 - 30 VDC at 3 - 30 amperes, 3 - 135 VDC at 1 - 10 amperes, and 100 - 300 VDC at 1 - 10 amperes.

Investigate NOW the cost of a NOBATRON installation versus the overall cost of less satisfactory DC sources.

COMMON NOBATRON SPECIFICATIONS

Input voltage range	95-130 VAC, single ϕ, 50-60 ~ High-current units 208/115, 3ϕ, 4-wire, wye.
Output voltage range	Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy.
Regulation accuracy	± 0.2% from 1/10 to full load.
Ripple voltage	1% RMS. Time constant 0.2 seconds.

* Reg. U. S. Pat. Off. by Sorensen & Co., Inc.

OTHER SORENSEN ISOTRONIC PRODUCTS INCLUDE:

B-NOBATRONS (high-voltage, low-current DC Supplies)
FREQUENCY CHANGERS VARIABLE AUTO TRANSFORMERS
SATURABLE CORE REACTORS AC LINE REGULATORS

SPECIFY SORENSEN

For Complete Information Write

SORENSEN & CO., INC.
375 Fairfield Avenue
Stamford 2, Conn.

nique for manufacturing special-purpose electron tubes: timing tubes, vertical sensing tubes, altitude sensitive cells, gaseous discharge tubes, spark gaps, Geiger-Muller counter tubes, coaxial noise diodes, and bolometers.—Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J.

U-1180 **Medium-Mu Triode.** New 2-page data sheet illustrates and describes maker's medium-mu triode Type 254. Includes average static characteristics and maximum ratings.—Lewis and Kaufman, Inc., Los Gatos, Calif.

U-1181 **Multi-Unit Miniature Tube.** New 4-page brochure describes maker's twin diode and medium-mu triode Type 12BF6. Gives characteristics, operating considerations, and dimensional outline. —RCA, Tube Dept., Harrison, N. J.

U-1182 **Reactance** Tubes. 18-page September issue of "Successful Servicing" presents article on use of reactance control tubes in television AFC systems. Includes article on stylus wear in high-fidelity reproduction and "Tek-File" service index.—John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y.

U-1183 **Half-Wave Vacuum Rectifier.** New Data Sheet 6AX4-GT contains operating data and characteristics of maker's half-wave vacuum rectifier "Type 6AX4-GT" for television damper service.—RCA Tube Dept., Harrison, N. J.

U-1184 **Cold-Cathode Tube.** New Bulletin 252 illustrates and describes maker's cold-cathode control tube "Model TT-1." Includes dimensions, characteristics, ratings, typical operation and applications.—Haledy Electronics Co., 57 William St., New York 5, N. Y.

U-1185 **Relays.** New 20-page catalog describes and illustrates 18 of maker's relays that resist heat, vibration, shock, and acceleration. Includes specifications, dimensions, and applications.—Neomatic Inc., 9010 Bellanca Ave., Los Angeles 45, Calif.

U-1186 **Attenuators, Switches, Resistors, Test Equipment.** New 135-page catalog describes and illustrates in detail maker's attenuators, switches, resistors, and laboratory test equipment. Includes engineering application data, charts, and complete specifications.—The Daven Co., 191 Central Ave., Newark 4, N. J.

U-1187 **Toggle Switches.** New 2-page Bulletin S1 illustrates and describes maker's line of toggle switches. Includes construction, ratings, and adaptations.—Hetherington, Inc., Sharon Hill, Penna.

U-1188 **Toggle Assemblies.** New 2-page illustrated Data Sheet 62 describes maker's toggle assembly with eight basic switches and other multiple unit assemblies. Includes ratings, construction, and prices.—Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.

U-1189 **Toggle Switch.** New Data Sheet 57 describes maker's hermetically sealed precision toggle switch. Includes construction, characteristics and electrical rating.—Minneapolis-Honeywell Regulator Co., Micro Switch Div., Freeport, Ill.

U-1190 **Coaxial Cable Connectors.** New 20-page Catalog 101 describes and illustrates maker's coaxial cable connectors. Includes descriptions, dimensions, impedance, cables used, and numbers of over 80 connectors.—Dage Electric Co., Inc., 67 North 2nd St., Beech Grove, Ind.

Compressors and Filters

U-1191 **Oil-free Compressors.** 4-page Bulletin 600 illustrates and describes "Class ATCL" compressors which feature steel-backed carbon cylinder-liner to produce oil-free compressed air or gas. Includes cut-a-way view, features, and design.—Pennsylvania Pump & Compressor Co., Easton, Penna.

U-1192 **Liquid Filters.** New 12-page illustrated Bulletin D-IL describes maker's complete line of liquid filters. Includes construction, operation, and specifications. Recommends filter media.—Dollinger Corp., 11 Centre Pk., Rochester 3, N. Y.

Research Facilities

U-1193 **Research Facilities.** New 4-page bulletin describes and illustrates technical services for government and industry by consulting firm. Includes chemistry, electromechanics, and combustion and jet propulsion.—Atlantic Research Corp., 812 N. Fairfax St., Alexandria, Va.

U-1194 **Metallurgy.** New 16-page brochure illustrates and describes research activities in metallurgy, dehydration, vacuum coating, and distillation.—National Research Corp., 70 Memorial Dr., Cambridge 42, Mass.

Dynamic Measurements

U-1195 **Dynamic Measurements.** New 4-page issue No. 23 of "Instrument Notes" contains comprehensive study of secondary effects in seismic-system instruments. — Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

U-1196 **Dynamic Balancing Machine.** New 2-page reprint discusses application of maker's dynamic balancing machine "Model NEH-136" which tests for wear and vibration in rotating parts of pumps or turbines.—The Globe Tool & Engineering Co., Dayton 3, Ohio.

A supply of these cards for the asking

Is your copy of *Instruments* routed to several people?

Does your Company Librarian forbid mutilating tech mags?

Or do you yourself wish to preserve your own copies intact?

Just drop us a postal card asking for Inquiry Cards and we'll send you twelve! Do it NOW.

NEW **PRECISION COUNTERS**

OFFER MANY EXCLUSIVE ADVANTAGES

***PLUS* LOW COST!**

1 1 1 3 0
PRECISION COUNTER
DITTMORE & FREIMUTH CO.
CUDAHY, WISCONSIN
MODEL
PATENTED

IDEAL FOR Punch Presses, Screw Machines, Printing Presses, Drill Presses, Die Casting Machines, Production Lathes, Pumps, Coil Winders, Conveyors, Etc.

PRECISION COUNTERS ASSURE *Accuracy • Durability • Visibility • Low Maintenance Costs*

Counters for Special Applications Designed and Manufactured

WRITE NOW FOR DETAILED SPECIFICATIONS

DITTMORE & FREIMUTH CO.

2517 E. Norwich Ave., Cudahy, Wis.

Instruments, 921 Ridge Ave., Pittsburgh, Pa. *(November 1952)*
Not good after Jan. 1, 1953

Please have the following pieces of LITERATURE sent to me:
Numbers ....

I desire further information on the following NEW INSTRUMENTS:
Numbers ....

I desire details on the following ADVERTISED PRODUCTS (Write page number and name of company) ....

Name .... ***Title*** ....
Please Print
Company ....
Co.'s Address ....

ADVERTISERS' INDEX

Acme Scientific Company 1612
Acragage Co. 1540
Acromark Company 1544
American Chain & Cable Co. 1619
American Machine & Metals, Inc. 1519
American Meter Co. .... Inside Back Cover
Amperite Co., Inc. 1623
Amthor Testing Instrument Co. 1542
Arma Corp. 1481
Arnold Engineering Co. 1488
Askania Regulator Company 1490
Audio & Video Products Corporation 1559

Bailey Meter Co. 1521
Baldwin-Lima-Hamilton Corp. 1608
Barber-Colman Company 1612
Barton Instrument Corp. 1537
Beckman Instruments Inc. 1486, 1624
Bendix Aviation Corp. 1563
Berkeley Scientific Div., Beckman Instruments, Inc. 1486
Bethlehem Apparatus Co., Inc. 1610
Black, Sivalls & Bryson, Inc. 1507
Bodine Electric Co. 1556
Boonton Radio Corporation 1621
Bridgeport Thermostat Div. 1511
Bristol Co. 1492, 1517
Burling Instrument Co. 1602

Cambridge Instrument Co., Inc. 1604
Cannon Electric Co. 1543
Century Geophysical Corp. 1564
Chester Cable Corp. 1502
Clare & Co., C. P. 1495
Conoflow Corporation 1597
Consolidated Engineering Corp. 1494
Cramer Company, R. W. 1610
Crosby Steam Gage & Valve Company 1493

Daven Co. 1605
DeJur Amsco Corporation 1622
Dial Light Co. of America 1605
Dittmore & Freimuth Company 1627
Dollinger Corporation 1505
du Pont de Nemours & Co., Inc., E. I. 1516, 1541
Durant Mfg. Co. 1605
Dwyer Mfg. Co., F. W. 1592

Edison, Inc., Thomas A. 1529
Electric Auto-Lite Co. 1576
Electric Indicator Co. 1551
Eppley Laboratory, Inc. 1609

Fairchild Camera & Instrument Corp. 1501
Falstrom Co. 1484
Fischer & Porter Co. 1489
Fisher Governor Co. .... Inside Front Cover
Foster Engineering Co. 1535
Foxboro Company 1496-1497, 1602
Friez Instrument Div., Bendix 1563
Fulton-Sylphon Division 1511

Gamma Instrument Company, Inc. 1546
General Electric Company 1503
Giannini & Co., Inc., G. M. 1545
Gordon Co., Claud S. 1620
Gow-Mac Instrument Co. 1601
Green Instrument Co. 1603

Hagan Corporation 1500
Hammel-Dahl Co. .... Back Cover
Hastings Instrument Company, Inc. 1621
Hathaway Instrument Co. 1560
Haydon Company, A. W. 1561
Hays Corp. 1617
Heise Bourdon Tube Co. 1560
Helicoid Gage Div. 1619
Helipot Corporation 1608

Imperial Brass Mfg. Co. 1597
Industrial Div., Minneapolis-Honeywell Regulator Co. 1514, 1554-1555, 1578, 1607
Industrol Corp. 1547
Instrument & Control Consultants 1628
Instruments, Inc. 1546
International Rectifier Corporation 1491

Jerguson Gage & Valve Co. 1532

Kemp Mfg. Co., C. M. 1601
Kieley & Mueller, Inc. 1482-1483
Kirk & Blum Mfg. Co. 1600

Lapp Insulator Co., Inc. 1549
Leeds & Northrup Co. 1510, 1524
Lévin & Son, Inc., Louis 1611
Lewis Engineering Co. 1485
Liquidometer Corp. 1609
Littleford Bros., Inc. 1618

Macbeth Instrument Corp. 1609
Machinery Lloyd 1598
Manning, Maxwell & Moore, Inc. 1577
Marsh Instrument Co. 1613
Marshall Products Co. 1603
Marshalltown Mfg. Co. 1604
Measurements Corp. 1558
Meriam Instrument Co. 1599
Mico Instrument Co. 1542
Minneapolis-Honeywell Regulator Co. 1514, 1554-1555, 1574, 1607
Moeller Instrument Co. 1597
Monsell, John R. 1561

Nash Engineering Company 1512
New Hermes, Inc. 1540
North American Aviation, Inc. 1538
North American Philips Company, Inc. 1611

Ohmite Mfg. Co. 1523

Palmer Thermometers, Inc. 1613
Panalarm Products, Inc. 1533
Passaic Analytical Laboratories, Inc. 1576
Permo, Incorporated 1562
Philadelphia Thermometer Co. 1592
Potter Aeronautical Co. 1518
Potter Instrument Company 1557
Preis Engraving Machine Co., H. P. 1548
Process Controls, Div. of Baird Associates 1552
Pyrometer Instrument Co. 1544

Radio Shack Corporation 1548
Rawson Electrical Instrument Co. 1576
Rochester Mfg. Co., Inc. 1563
Rockwell Co., W. S. 1564
Rohm & Haas Company 1564
R-S Products Corp. 1522
Rubicon Co. 1606

Scientific Instrument Co. 1628
Servomechanisms, Inc. 1553
Servo-Tek Products Co. 1534
Shallcross Manufacturing Company 1531
Shore Instrument & Mfg. Co. 1550
Sola Electric Co. 1508
Sorensen and Company 1626
Standard Cabinet Co. 1562
Struthers-Dunn, Inc. 1625
Sun Electric Corporation 1601
Superior Electric Co. 1513
Superior Tube Company 1506
Swartwout Company 1615
Sylvania Electric Products Inc. 1565

Taber Instrument Corporation 1558
Taylor Instrument Companies 1498-1499
Telecomputing Corporation 1515
Trerice Co., H. O. 1539
Trinity Equipment Corp. 1556

Uehling Instrument Co. 1576
Unertl Optical Co., John 1550
United States Gauge, Div. of American Machine & Metals, Inc. 1519

Vapor Recovery Systems Company 1536
Veeder-Root Inc. 1520

Wallace & Tiernan Products, Inc. 1509
Waterman Products Co., Inc. 1616
Webber Appliance Co., Inc. 1603
Weksler Thermometer Corporation 1611
Welch Scientific Co., W. M. 1529
Weston Electrical Instrument Corp. 1487, 1504
Wheelco Instruments Division, Barber-Colman Company 1592
White Dental Mfg. Co., S. S. 1565

INSTRUMENT & CONTROL CONSULTANTS

Engineering Services, Testing Laboratories and other Professional Services

FLUID CONTROLS CO., INC.

Control Engineers

Procurement, Application, Design and Installation Supervision of control systems in Refining, Chemical, Aircraft, Paper, Power and associated industries.

NEW YORK PHILADELPHIA BALTIMORE
(28)

ENGINEERING DIVISION
M. S. JACOBS & ASSOCIATES, INC.

APPLICATION & ENGINEERING OF INDUSTRIAL PROCESS CONTROLS SPECIALIZING IN THE STEEL & CHEMICAL INDUSTRIES.

810 NOBLESTOWN ROAD • CARNEGIE, PA.
TELEPHONE (Pittsburgh, Pa.) Walnut 1-6140

Your card as per above in 12 issues of
INSTRUMENTS for $100, payable in advance.

FIRST CLASS
PERMIT No. 1441
(Sec. 34.9 P. L. & R.)
PITTSBURGH, PA.

BUSINESS REPLY CARD
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

4c-POSTAGE WILL BE PAID BY—

INSTRUMENTS PUBLISHING CO.
921 Ridge Avenue
Pittsburgh 12, Pa.

SALES REPRESENTATIVES WANTED

Manufacturer of wide line of industrial and dial thermometers, controllers, and recorders has exclusive and lucrative territories available in large Cities for qualified men in this field. Write fully to:

SCIENTIFIC INSTRUMENT CO.
1041 Second Ave.
Detroit 26, Michigan

77
13
03
04
58
99
42

07
97
61

12
40
38
11

23

13
33
76
62
92
18
57
48
52
44

48
76
63
64
64
22
06

28
53
34
31
50
08
26
62
25
01
13
06
15
65

58
99
15
39
56

76
50

19

36
20

09
16
03
11
29
04

92
65